B-GL-321-001/FT-001

SIGNALS IN BATTLE

VOLUME 1

PRINCIPLES AND EMPLOYMENT

(BILINGUAL)

(Supersedes B-GL-321-001/FT-001 dated 1986-07)

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FOREWORD

APPLICATION

1. B-GL-321-001/FT-001, Signals in Battle, Volume 1, Principles and Employment is issued on the authority of the Chief of the Defence Staff. It is effective on receipt and supersedes B-GL-321-001/FT-001, Interim 2, Signals in Battle, Volume 1, Principles and Employment which shall be destroyed.

2. Suggestions for amendments should be forwarded to Mobile Command HQ, Attention: Senior Staff Officer Signals.

AIM

3. This publication states the Signals doctrine for army field operations.

SCOPE

4. The doctrine is applicable to all scales of conflict and to all levels of command within an area of operation. The publication describes:

a. the requirement for a command and control information system;

b. the principles for the provision of this system;

c. the characteristics of major system components;

d. the organization of field Signals; and

e. the major tactical considerations which affect the provision of communications on the battlefield.

CONTEXT

5. This is the principal manual in the 321 series. Signals in the Brigade and the Brigade Group, Signals in the Corps and the Division, and Tactical Electronic Warfare complement this manual and provide more specific doctrine appropriate to the handling of signal units at various levels of command. The cut-off point between the various manuals is arbitrary and some overlap is inevitable despite the author's effort to reduce redundancy.

6. The primary references were:

a. Land Force Combat System Study;

b. Land Force Combat Communication Study;

c. Land Force Electronic Warfare Study;

d. B-GL-300-000/FP-000 Interim 1, The Army, 20 Apr 84;

e. B-GL-301-001/FT-001, Land Formations in Battle; and

f. B-GL-311-001/FP-001, Administration in the Field.

7. Other references used are listed in Annex A.

TERMINOLOGY

8. The terminology used in this manual is consistent with that of the Army Glossary and AAP-6, NATO Glossary of Terms and Definitions. For technical terms, the references used are ACP 167, the CF Electronic and Telecommunication Vocabulary 1984 and those terms authorized by the Working Group on Signal Terminology, a subsidiary body of the Army Doctrine and Tactics Board.

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CHAPTER 1

THE FUNDAMENTALS OF COMMAND AND CONTROL

SECTION 1

COMMAND AND CONTROL REQUIREMENTS

COMMAND AND CONTROL

1. Command is defined as the authority vested in an individual of the armed forces for the direction, co-ordination, and control of military forces.

2. Control is the authority exercised by a commander over part of the activities of subordinate organizations, or other organizations not normally under his command, which encompasses the responsibility for implementing orders or directives.

COMMAND CONTROL AND INFORMATION SYSTEM (CCIS)

3. The exercise of command and control by commanders is accomplished through a specific system which is known as a command, control and information system (CCIS). A CCIS is an integrated system comprised of doctrine, procedures, organizational structures, personnel, equipment, facilities and communications which provides authorities at all levels with timely and adequate data to plan, direct and control their activities. In concrete terms, the army CCIS is made up of the following major components.

a. **A Chain of Command**. A chain of command has designated commanders at various levels and for designated functions. Their responsibilities have been described in B-GL-300-000/FP-000, Chapter 8. This CCIS component will not be discussed any further in this publication.

b. **A Staff System**. It is described in B-GL-300-000/FP-000, Chapters 8 and 9. It will not be discussed any further in this publication.

c. **Headquarters Facilities**. The functioning of headquarters will be discussed in detail in this publication.

d. **An Automated Combat Information System (ACIS)**. It is made up of automated data processing (ADP) equipment and staff procedures, and is used by commanders and their staff in order to assist in accomplishing their command and control functions. ACIS is discussed later in this publication.

e. **Various Communication Systems**. These are the transparent threads binding all the other components of the CCIS. They are discussed in detail in this publication.

RESPONSIBILITY OF SIGNALS

4. **General**. Since 1903, the army in Canada has assigned the responsibility for the provision of its CCIS (less command and staff) to a combat support arm - Signals. The doctrine to execute this responsibility is the subject of this publication. All further reference to the CCIS in this manual shall be understood in this restricted sense.

5. **Role**. The role of Signals is to provide commanders and their staff the means to exercise command and control, and to deny and exploit the enemy's use of the electromagnetic spectrum through electronic warfare.

6. **Tasks**. The major tasks of Signals are:

a. provision of advice to commanders and staff on all aspects of Signals duties;

b. operation, engineering and technical control of communications including net radio, trunk systems and dispatch service;

c. conduct of electronic warfare (EW);

d. provision of automatic data processing (ADP) in support of command and control;

e. performance of communications and electronics equipment maintenance within the land ordnance engineering system; and

f. provision of administrative support and local defence of formation headquarters.

7. **Signals to Staff Relationship**. Since the CCIS is absolutely vital to commanders and their staff, they must take an active interest in its operation and must understand the challenge faced by Signals. On the other hand, Signals must have a thorough understanding of tactical operations in order to anticipate the command and control requirements. Field headquarters will be fully effective only when good relations and effective co- operation exist between the staff and Signals. The mutual duties which will ensure this state of harmony are as follows:

a. **Duties of the Staff Towards Signals**. The staff must:

(1) give early warning of intention including tactical plans, grouping, movement of HQ and units, statement of communication requirements and estimated traffic density;

(2) state signal security policy;

(3) state policy on electronic warfare;

(4) issue instructions regarding opening and closing of communication facilities;

(5) issue instructions for the collection of dispatches by visiting officers;

(6) issue instructions for the use of signals despatch service (SDS);

(7) enforce signal traffic procedures including precedence, security classifications, sigsec procedures, minimize procedures;

(8) ensure training for all users in signal procedures, voice procedures, voice codes, message writing and proper use of communications facilities;

(9) ensure regular collective signal exercises and training on all systems; and

(10) ensure training for all users in the offensive and defensive aspects of electronic warfare.

b. **Duties of Signals Towards the Staff**. In furtherance of the general tasks described at paragraph 6 above, signals must perform the following specific duties:

(1) advise the commander and staff on siting of the HQ, allocation of resources by priority, best use of available resources, training of users, implementation of signal security policy and employment of EW resources;

(2) draft the C&E annexes to the operations orders;

(3) issue all relevant signal instructions; and

(4) execute the agreed communication plan by issuing the time of opening/closing communication facilities, providing communication states, informing on traffic delays, monitoring signal security and reporting breaches, issuing official time and supervising the work standards of operating personnel.

MAJOR FACTORS

8. **General**. Major factors affecting the provision of the CCIS are:

a. mission of the supported force;

b. enemy threat;

c. characteristics of the supported force;

d. characteristics of the area of operations;

e. operational environment; and

f. international agreements related to CCIS components (STANAG/QSTAG).

9. **Mission**. This is the single most important factor as it affects all other factors. Besides the assigned mission, the signal commander must understand the supported commander's intention, his concept of operation, the related tasks, groupings and timings.

10. **The Threat**

a. On the high intensity battlefield, control of the electromagnetic spectrum will be of paramount importance. The potential enemy recognizes this and has developed a sophisticated "Radio Electronic Combat Support" (RECS) doctrine. This doctrine aims at destroying 30% of our CCIS and neutralizing another 30% through intrusion, deception, jamming and physical attack. Likely target priorities are:

(1) **Nuclear Weapon Systems**. Included are the means of delivery, storage areas and associated control systems.

(2) **Artillery**. This includes artillery associated communication and target acquisition systems.

(3) **Command and Control Systems**.

(4) **Airborne Radar and Ground to Air Communications**. Forward air control links may receive special emphasis.

(5) **Air Defence Systems**. Targets include communication equipment, and radars used for detection, fire control and target acquisition.

(6) **Reserves**

b. Actions and reactions of the enemy must be analysed to determine the best method for command and control. Steps must be taken to eliminate opportunities for the enemy to interfere with our CCIS and to minimize the effects of enemy action.

11. **Characteristics of the Supported Force**. The size and type of supported forces will influence the complexity, quality and nature of the required CCIS components. For example, the needs of an airborne brigade are very different from those of an administrative formation, like a Divisional Service Group.

12. **Characteristics of the Area of Operations**. The communication component of the CCIS will be influenced by the nature of the ground, distances to be covered, dispersion of the supported forces and meteorology in the area of operations.

13. **The Operational Environment**. The command and control doctrine, the tactics and/or the strategy, and the NBCW conditions will all have a profound influence on the various components of the CCIS.

14. **International Agreements**. In the context of alliance warfare within NATO, the army CCIS is subject to various constraints as a result of international standardization agreements (STANAGs). These cover communication requirements, staff and signal procedures, and equipment, engineering and interoperability standards. Annex A shows the present list of STANAGs which must be complied with.

SECTION 2

PRINCIPLES

PRINCIPLES

1. To be effective and meet the general requirements stated above the CCIS must be provided in accordance with certain principles. All of these principles are interrelated although they may not be mutually compatible in all circumstances. Their application and their relative importance must therefore be weighed against the specific needs in every situation.

2. The principles of an effective CCIS are:

   a. capacity,

   b. economy,

   c. flexibility,

   d. mobility,

   e. reliability,

   f. security,

   g. simplicity,

   h. survivability, and

   j. timeliness.

CAPACITY

3. The system must be capable of handling the traffic generated by the users within the specified time frame, in the required mode and without inhibiting the tempo of operations. Constant monitoring of the CCIS must be carried out to ensure that operated systems are engineered to meet the capacity needed for peak loads. These peak load periods can be anticipated with the co-operation of users.

ECONOMY

4. The increasing complexity of warfare means that more and more of the effort has to be diverted from the primary function of fighting to tasks which, although essential, are ancillary. One of these tasks is the provision of a CCIS. It must therefore be as economical as possible and demand the least amount of human and material resources for its operation and maintenance. It is

important that CCIS facilities be allocated in accordance with operational priorities and that their use be strictly controlled to ensure they serve the intended purpose.

5. Economy is realized by ensuring that:

   a. demands for facilities are kept to a minimum;

   b. signal plans are based on the minimum scale needed to accomplish the tactical mission; and

   c. signal spares and reserve holdings are properly planned to promote reliability and flexibility.

FLEXIBILITY

6. This is the ability to react to changing situations and unexpected developments. Changes in requirements may result from alterations to operational plans or from enemy action.

7. Flexibility also implies the ability to provide systems which are interoperable and can be adapted to diverse operations and/or combat functions.

8. Flexibility is gained by:

   a. forethought in planning and anticipation of contingencies;

   b. standing operating procedures and drills to reduce the time needed to plan and redeploy CCIS components;

   c. a high standard of efficiency in establishing and maintaining CCIS components;

   d. close co-ordination between the user and the signal planner; and

   e. systems which are user-oriented and can be used for a variety of combat functions.

MOBILITY

9. This is the ability to deploy everywhere on the battlefield and to meet the needs of the user without restricting his freedom of action and his ability to manoeuvre. CCIS components must have the same tactical mobility as the forces being supported.

10. Mobility is also enhanced by the design of communication systems which allow for separate movement of user headquarters and signal facilities (eg, an area trunk system).

RELIABILITY

11. Reliability is the capability of a system to operate efficiently within the specified performance standards, for a planned period of time and under the conditions likely to be encountered. The system must remain available to the user for traffic despite damages, and technical failures. Its maintenance and restoral requirements must be satisfied within allowed and available resources.

12. Reliability is mainly achieved by providing:

a. **Diversity**. The provision of multiple means for a particular combat function lessens the probability of total failure.

b. **Alternative Routing**. Communication systems must be designed to provide alternative paths between points in the system so that the loss of a single facility or link does not result in the failure of the system.

c. **Reserve**. To replace a disrupted portion of the system, a reserve of personnel and equipment must be available. To be effective this reserve must be located and placed on an appropriate stand-by status so as to be able to intervene quickly.

d. **Training**. A high standard of individual and collective competence among all personnel assigned to the CCIS must be maintained in order to meet the challenges of the battlefield in an NBCW and RECS environment.

e. **Maintenance**. The system must be engineered so as to be easy to maintain with few resources. In the combat zone, the maintenance system must be capable of immediate restoration of key elements.

SECURITY

13. Security measures must be applied strictly in order to:

a. deny unauthorized persons information of value which might be derived from monitoring CCIS components; and

b. prevent intrusion and imitative deception.

14. To achieve security it is essential that every CCIS user know and observe the signal security procedures established to ensure the protection of classified traffic, documents and equipment.

SIMPLICITY

15. The simpler the system, the more likely it is to withstand the stresses of war. Simple systems are easily operated, readily adaptable and easy to deploy and maintain.

16. CCIS components must be designed as much as possible to be operated by users with minimum training. Any design that increases the level of technical complexity must produce equivalent improvements in operational effectiveness.

SURVIVABILITY

17. The system has to be capable of withstanding physical and electronic attacks by the enemy. In particular, equipments must be designed to operate effectively in an environment with a severe RECS and EMP threat. Equipments have to be hardened, facilities protected and alternate facilities provided. Personnel are to be well trained in defensive measures, ECCM procedures and restoral drills.

TIMELINESS

18. Combat information has a short useful life span. In order to be successful commanders must complete their command and control process in a shorter time frame than their opponents. The CCIS components must therefore be engineered, organized and operated so as to allow the processing and transmission of combat information within the required time frame. Staff and signal personnel are to be imbued with a sense of urgency.

CHAPTER 2

THE AUTOMATED COMBAT INFORMATION SYSTEM (ACIS)

SECTION 1

THE REQUIREMENT

BACKGROUND

1. Command and control has always been a vital aspect of military operations, but only recently has it used such an extensive amount of sophisticated technology. Recent technological advances have had a significant impact in such areas as reconnaissance, surveillance and target acquisition devices. Today's weapon systems have greater range, speed, and accuracy; at the same time, intelligence and surveillance improvements are producing more information over greatly increased distances. The real size of the battlefield has increased. Sensor coverages and capabilities overlap and need careful coordination. Other improvements will enhance the mobility and the night-fighting capability of tactical forces, resulting in an increased tempo of operations. Consequently command and control of forces will depend to an unprecedented degree on communications and the ability to process the information fast enough for decisions to be relevant. In the presence of an increasing RECS threat and the corresponding need for small, mobile and low-electronic-profile headquarters, automation of information handling is the most logical method of speeding up the command and control process.

THE BATTLEFIELD COMMAND AND CONTROL PROCESS

2. The process of command and control varies in complexity with the level of command and the function of the commander, but it can nevertheless be broken into a few common basic steps which are explained below.

3. **Combat Information Collection**. The command and control system has to inform the commander about the state of the environment, about the enemy and about his troops. The collection of combat information from all available sources must be planned and methodical, and permit the integration of information from all sources.

4. **Combat Information Processing**. The collected combat information must be interpreted and evaluated; the compilation of information files appropriate to the combat function supported must be carried out in a time frame as close to real time as possible because of the short life span of combat information.

5. **Combat Information Distribution**. Selected combat information has to be distributed instantaneously to lower and higher echelons and laterally within headquarters so as to permit maximum simultaneous action and unity of action/purpose. Conversely peripheral users must be allowed selective access to information files. The judicious distribution of combat information also contributes to the survivability of the system; this, however, demands increased communications.

6. **Planning and Decision Making**. Combat information must be presented to the commander and his staff in such a way as to hasten and simplify the planning and decision-making process. This means that ACIS must allow in turn the analysis of specific aspects of the battlefield and the synthetic view of the battlefield situation at desired levels. Whenever possible factor analysis and option formulation must be automated.

7. **Issue of Orders**. Facilities are to be provided for the issue of orders and instructions which must be received clearly, in a readily usable form and in sufficient time for subordinates to carry out their own battle procedures.

8. **Control of Forces**. The command and control system must provide facilities for the commander and staff to monitor and control the execution of their plans and orders.

SECTION 2

SYSTEM CHARACTERISTICS

BASIC CHARACTERISTICS

1. An ACIS must have the following basic characteristics:

   a. allow the timely and easy execution of the command and control process described at paragraphs 2 to 8 above;

   b. be capable of transmitting over planned combat communication systems (line, combat net radio (CNR), and area communication systems) and be resilient to failure of communication paths;

   c. be capable of protecting itself against enemy interference and intrusion and of limiting information yielded to the enemy;

   d. serve the following combat functions:

      (1) operations,

      (2) intelligence,

      (3) fire support,

      (4) air defence and airspace management, and

      (5) combat service support;

   e. allow the transfer and integration of combat information between the above sub-components, to and from automated weapon control systems, other single arm/service ACIS sub-components and allied ACIS; and

   f. enhance the survivability of the command and control process against destruction through appropriate hardware diversity, hardening and mobility, and information distribution.

2. If automation is to bring all the hoped for advantages, the man- machine interface (MMI) must be particularly well researched and involve software presentation, battle procedure assistance, hardware arrangements and take into account the impact of the physical and operational environments on the operators of the system. ACIS must be fully operable by staff officers and staff assistants who will work side by side and complement each other's effort. The staff assistant will concentrate on information receipt, collection, collation and transmission and interface with the communication systems while the staff officer will concentrate on information interpretation, evaluation, option formulation and presentation to the appropriate commander.

Man-machine dialogue and information processing by the users will be carried out in natural languages (English or French) because the system and application softwares will be built around high-level, advanced software languages such as ADA, Pascal, etc.

SYSTEM DEVELOPMENT

3. The development of an ACIS is done through a system analysis which involves two important partners: the commander/user and the Signals specialist. The commander/user will be responsible for the clear and accurate definition of the capabilities required. It is for the user to decide whether the capability defined is correct, and whether this capability can be achieved within the technical and financial resources. The Signals specialist will then conduct an analysis of the capability requirements and propose several options (outline systems) to the user. The latter must then decide which option is best; in this regard, it is important to avoid ideal and complex Solutions. The technical risk must be reasonable and the system simple enough to gain the intended user's confidence. Involving the user in the system analysis and the analyst in the system implementation are adequate safeguards against these dangers.

4. Once an outline system has been approved by the user, the Signals specialist can then move onto the detailed system design. At this point, it is very important that all possible interactions of the system with other systems be studied in detail. For example, an ACIS will have to interface with various combat communication systems (trunk, CNR) and other ACIS or weapon systems. One very important decision to be made at this stage is the distribution of the processing power and the data base. It can range from a monolithic system shown in Figure 2-1 to a fully distributed system in Figure 2-2.

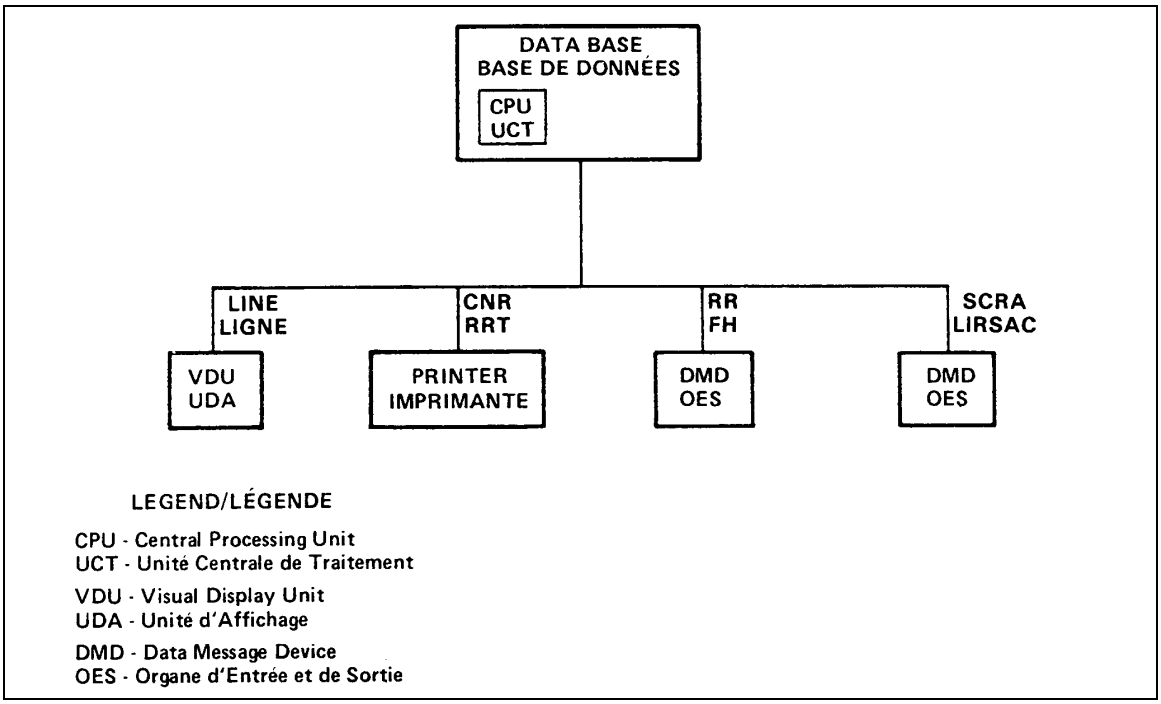

Figure 2-1 A Monolithic System

5. A monolithic system has a single central processing unit and data base with terminals such as visual display units, printers, and data message devices which are attached directly or via extended communication links such as radio relay, line, CNR or single channel radio access. Such a system is vulnerable in that a failure of the processor renders the system inoperative. A fully distributed system has processing power and a complete copy of the system data base at each node of the system. Nodes are interconnected by communication links and an amendment to the data base of one node automatically transmits to all other nodes. Thus the failure of a node does not seriously degrade the functioning of the remaining system. But this is very costly in communication links, time and storage facility.

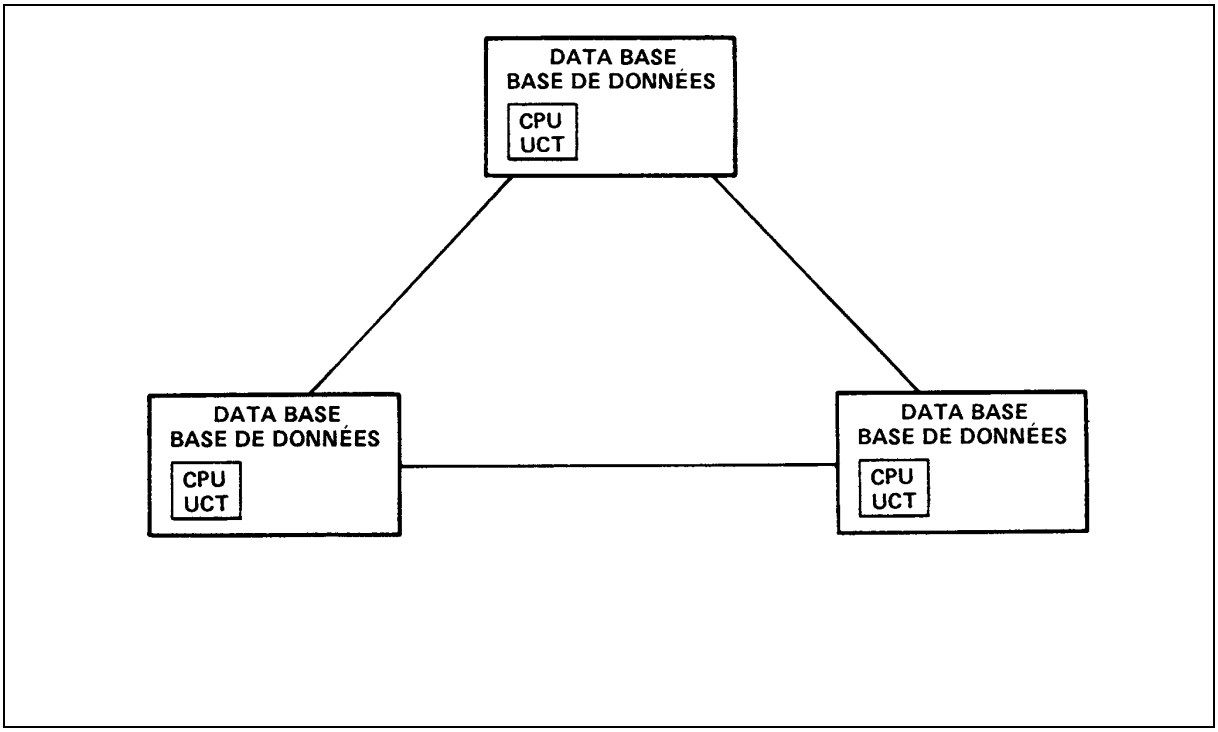

Figure 2-2 A Fully Distributed System

6. In practice, proposed solutions strike a balance between these two extremes. For example, in an ACIS, it is not necessary for all HQ or all staff cells within a HQ to hold a complete copy of the data base. The cost of expensive data stores can be reduced by identifying critical data holding requirements. Intelligent terminals (terminals with some processing power), mini computers or micro computers can handle messages, reduced data bases and provide displays without recourse to a central processor's data base. Such peripherals can be used to good effect in balancing design.

7. In the detailed design process, the Signals specialist will adopt an iterative, top down approach. A general sequence of work is to consider the outputs required, then the inputs available, followed by the procedures, data bases and files which will be necessary. Then specify security safeguards, staff requirements, organizational changes and the normal procedures required to support the new system. A software plan will be followed by a definition of hardware requirements. All this will then be placed in an implementation plan submitted for the user's approval. After approval, the project is implemented in a manner similar to that of other types of projects.

SECTION 3

THE CANADIAN ACIS

TO BE ISSUED

This section is reserved for the description of the Canadian ACIS, which is now in the preliminary definition stage in NDHQ.

SECTION 4

ALLIED ACIS SYSTEMS

GENERAL

1. Most of the NATO countries with which Canadian land forces may be expected to operate have developed or are developing ACIS for their land forces. Highlights of the basic structure and capabilities of these systems follow.

FRANCE. SACRA. (To be issued)

GERMANY. HEROS. (To be issued)

NORWAY. NORCISS. (To be issued)

USA. SIGMA. (To be issued)

UK

2. Started in 1966 under the codeword WINDSOR and redefined in 1968 as WAVELL. A decade later the commercial version of the first equipments were fielded with a division of 1 (BR) Corps and Corps HQ. 1 (BR) Corps commenced receiving equipment designed to requirements in 1985.

3. Essentially WAVELL is an information storage and retrieval system with a distributed data base. It automatically stores and distributes data via trunk communications from individual subscribers to all others. Manual information recording is reduced to a minimum and the use of data transmission reduces traffic load on command radio nets. Data can be rapidly retrieved from the data base. Consequently a transfer of command between two HQ requires only that the new HQ is connected into the Wavell network for a rapid update of its data base. This is far less disruptive of the command process than in a manual system.

4. Selected staff cells at Corps, Division and Brigade HQ are provided with VDUs and hard copy printers. Each HQ has its own database made up of data input by its own staff and other data provided by other cells. Interface with the Ptarmigan trunk communication system is achieved through a data channel switch, consisting of a processor, a multiplexer and a program loading unit, at each access node.

CHAPTER 3

THE MEANS OF COMMUNICATIONS

SECTION 1

INTRODUCTION

GENERAL

1. The means of communication as defined in the current Canadian approved edition of ACP 121 are:

a. **Telecommunications**, composed of the following:

(1) electrical/electronic,

(2) visual, and

(3) sound; and

b. **Physical communications**, which include:

(1) mail,

(2) messenger/courier, ie, hand carriage, or

(3) trained animal (this is not an established means of communication in the Canadian forces and no further reference is made to it).

TELECOMMUNICATIONS

2. **Electrical/Electronic Means**. Electrical/electronic means include radio and line systems which furnish rapid, high-capacity communications needed for the conduct of operations. The following are the common modes of operation:

a. **Telephony (Voice)**. This is the transmission and reception of speech. It is still the most common method available to tactical land forces using radio, or line.

b. **Telegraphy (CW)**. Telegraphy is the transmission and reception of international Morse code signals. Manual key, semiautomatic devices and recording equipments may be used for this purpose. It is a relatively slow method and generally used only for formal written messages. Its chief merits are simplicity and its capacity to communicate at ranges or through interference that preclude voice transmission. The efficiency of CW communications depends greatly upon operator skill.

c. **Teletypewriting**. This is the transmission of signals by means of a keyboard instrument over radio or line. Signals are automatically recorded in the form of printed characters on page copy or tape by the receiving instruments. It is a faster method of communication which can be established in a common user or a dedicated user mode.

d. **Facsimile**. Facsimile is the transmission of fixed images with subsequent reproduction in permanent form. It is used for the transmission and reception of pictures, maps, traces or other similar graphic material. Currently, it is still a relatively slow method of transmission requiring high-quality, voice circuits but technology is improving rapidly in this area and promises great improvements in speed and image quality.

e. **Television**. This is the transmission and reception of transient images of fixed or moving objects. Television communication requires complex terminal equipment and high-quality, broad band transmission circuits.

f. **Data**. This is the transmission and reception of information in digital form. Analogue information may be transmitted by this method but must first be converted into digital form. Data may be transmitted in fully automated modes and at high speeds. In the future, it will be associated with automated weapon system control and ACIS.

3. **Visual Means**. Visual means are those methods of transmission that can be received by optical means. Visual means are available to everyone and are useful to send simple, prearranged signals over short distances. Visual codes are insecure and can be imitated by the enemy to deceive and confuse. Still, for short range communications, they are preferred over radio which by comparison is more vulnerable to enemy actions. Some of the methods are:

a. arm and hand signals;

b. aircraft manoeuvres;

c. directional and non-directional flashing and coloured lights;

d. flags;

e. infra-red;

f. pyrotechnics (as authorized in ACP 168 current Canadian approved edition);

g. panels; and

h. in the future, communication system using laser as a transmission means may be operationally feasible.

4. **Sound**. This means of communication utilizes sound signals for the transmission of intelligence over audible ranges such as whistles, horns, sirens or voice amplifiers. Sound signals are vulnerable to interception and their usefulness may be impaired by local and battle noises.

PHYSICAL COMMUNICATIONS

5. **Mail**. Mail is the means of forwarding record traffic by established postal service. Although useful for some forms of signal traffic, postal systems do not normally afford the speed or security needed for tactical communications in support of command and control and are not described further in this manual.

6. **Hand Carriage**. This means differs from mail in that signal traffic is physically carried, and is entrusted to an individual's custody through all stages of the transmission process. it is, therefore, organized as a communications activity in support of operations, as opposed to the postal service which is generally conducted as an administrative function. The characteristics of this means are outlined in Sect 4.

TRANSMISSION CAPACITY

7. It is evident that the electrical/electronic means best satisfy the tactical requirements for rapid, high capacity communications. The ability to use these means will depend on the characteristics of the information to be transmitted, the distances to be covered and the operational environment. The amount of information that can be transmitted by electrical/electronic means depends on a number of technical factors. The three most important factors are:

a. signalling speed;

b. redundancy; and

c. bandwidth.

8. **Signalling Speed**. The amount of information that can be passed will vary directly with the rate at which it can be transmitted and received. However, this by itself may be misleading as it gives no indication of response time. Speech rates over voice circuits average less than 100 words per minute; however, the response time for person-to-person conversation is fast. Teletypewriting transmission speeds are slightly higher but, under certain conditions, this may be offset by the handling times required by the originator and addressee and, in manual systems, by the cross-office time required at the terminals and relay points. Data transmission is very fast, enabling users at different levels of command, at different locations, to access information concurrently in a "near real-time" or "real-time" manner.

9. **Redundancy**. Redundancy is the proportion of non-essential information that the system passes while conveying the essential information. Visual modes of transmission possess more

inherent redundancy than speech modes while the latter are more redundant than telegraphy, teletypewriting or data modes.

a. **Visual**. The amount of redundancy inherent in facsimile and television depends on the picture to be transmitted. In both cases it is considerably greater than speech.

b. **Speech**. Normal conversation is not formalized: it is usually spontaneous as opposed to deliberate and condensed. Speech transmissions include all unproductive pauses and noises made in order to create a sense of intimacy between speakers.

c. **Data, Teletypewriting and Telegraphy**. In that order, these are the least redundant modes of transmission but the length, number, and spacing of the code elements introduces some redundancy to gain readability and accuracy.

10. **Bandwidth**. Bandwidth is the frequency range over which a transmission circuit is allowed to operate. Transmission capacity is proportional to the allowed bandwidth of the circuit. The necessary bandwidth is the minimum value of bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed. Some of the effects of transmission modes on bandwidth are as follows:

a. **Telegraphy (CW)**. The comparative slowness of this mode and the simplicity of the signal elements permit the use of narrow bandwidths (120 Hz).

b. **Data**. The transmission requirements for coded data such as used in ADP systems or telemetry are similar to telegraphy except that much higher speeds are generally needed and the acceptable error rates are normally less. This leads to wider bandwidths being utilized (16 kHz for a typical tactical data system).

c. **Voice**. Voice may be transmitted in analogue form, over a 3 kHz bandwidth, because, the electrical signal is a direct analogue of the voice signal; when voice is converted to a type of code, and put in digital form, it can be transmitted over difficult paths but at the expense of a greatly increased bandwidth (30-40 kHz).

d. **Facsimile**. A still picture can be transmitted slowly over a voice circuit or more rapidly over a circuit of greater bandwidth.

e. **Television**. The reproduction of a moving or transient image requires a bandwidth some five hundred or more times larger than that required for a single voice circuit (up to 3 MHz). However, low definition systems can be operated on reduced bandwidths.

MODULATION SYSTEMS

11. **Modulation**. Modulation is the process by which the intelligence to be transmitted, eg, the voice signal, is superimposed on the radio or carrier wave. Common terms associated with modulation systems used with tactical radio are:

a. Amplitude Modulation;

b. Frequency Modulation;

c. Phase Modulation;

d. Pulse Modulation; and

e. Spread Spectrum Techniques.

12. **Amplitude Modulation (AM)**

a. The amplitude of the carrier wave is varied in accordance with the signal carrying the intelligence. A complex wave form results consisting of the original carrier wave plus two bands of frequencies called sidebands, one above and one below the carrier frequency. The system is simple but not very efficient since both sidebands contain the same intelligence and the carrier wave contains none. This modulation technique is also prone to carrying both man-made and natural electrical disturbances. All older, high frequency (HF) radios employ AM.

b. **Single Sideband (SSB)**. This is a form of AM in which only one of the sidebands is transmitted; the second sideband and the carrier may be suppressed. Compared with double sideband AM, SSB increases by about 50% the ground wave range for a given weight of radio and battery, and occupies a much narrower bandwidth. SSB adds to the complexity of the radio set and requires a high standard of frequency stability. Independent sideband (ISB) is a variation on this system in which both sidebands are transmitted but each one is modulated with a different intelligence signal.

13. **Frequency Modulation (FM)**. In this method of modulation, the frequency of the carrier wave is varied by the intelligence signal. The resulting radio system is more complex than in AM but is considerably more efficient: it provides higher quality circuits with better signal-to-noise ratios and weak interfering signals are suppressed. On the other hand, the transmitted signal occupies a wide bandwith, a result which precludes its use below very high frequency (VHF) and limits its range. FM is the standard method for combat net radio (CNR).

14. **Phase Modulation (PM)**. In this method, the phase of the carrier wave is modulated by the intelligence signal. This technique is used either as a preliminary stage to FM to avoid the need for extensive frequency stabilization or alone. In this latter case, it requires a wide bandwidth.

15. **Pulse Modulation**. An alternative method to the transmission of intelligence by a continuous wave is the transmission by a series of short carrier-wave pulses. The most frequently used variants of this technique are:

a. **Pulse Amplitude Modulation (PAM)**. The mixing of the intelligence wave and the carrier wave is done as for normal AM except that the transmitter is turned on and off. The pulses are equally spaced and of equal duration (1 to 3 microseconds) but vary in amplitude. This technique produces very low average power in relation to peak power and allows the driving of the transmitting circuits far above their normal power ratings for continuous operation. A second advantage is increased signal-to-noise ratio if the receiver is silenced during the pulse intervals.

b. **Pulse Frequency Modulation (PFM)**. The mixing of the intelligence wave and the carrier wave is done as for normal FM except that the transmitter is turned on and off. In this case, the amplitude of the pulses remains constant and the frequency of the carrier is made to vary from pulse to pulse by the modulator. This technique provides the same advantages as PAM under the same conditions. PAM and PFM techniques can be combined to achieve diplexing.

c. **Pulse Width Modulation (PWM)**. In this method, the transmitter produces carrier pulses of constant amplitude and frequency but of varying duration. The duration or width of the pulses is varied in accordance with the amplitude of the modulating signal while the frequency of the pulse variations is made equal to the modulating frequency. This technique is readily adaptable to multiplexing in telephony.

d. **Pulse Time Modulation (PTM)**. Contrary to previous pulse modulation variants where at least one characteristic of the pulse is altered in accordance with the audio modulating signal, in this technique, a series of pulses are transmitted, which are of constant amplitude, duration and frequency but with variable timing. The time interval between successive pulses is made to vary in accordance with the instantaneous amplitude of the modulating signal. The frequency of the pulses is governed by the frequency of the modulating voltage. This technique has the following advantages: the signals are very simple; noise can be considerably reduced to achieve higher signal-to-noise ratio than AM or FM systems; the total bandwidth requirement of a PTM system is independent of the number of channels used. This technique is widely used in multi-channel radio and cable telephone communications, ultra high frequency (UHF) broadcasting and TV sound channels.

e. **Pulse Code Modulation (PCM)**. In this form of modulation the amplitude of the modulating signal is sampled at regular intervals and transmitted as a binary code group of pulses. The size of the group of pulses increases with the requirement for higher fidelity with an attendant increase in bandwith. Digital techniques are advantageous in that much more intelligence can be transmitted at a faster rate

compared to the other forms of modulation. Also, the encryption of voice signals is much simpler to accomplish when the intelligence is converted into digital form from its initial analogue form. These systems require a wide bandwidth for more efficient operation and are, therefore, suitable for high capacity trunk circuits.

f. **Delta Modulation (DM)**. This modulation uses the same technique as PCM; however, instead of the absolute signal amplitude being transmitted, at each sample, only the changes in signal amplitude from sampling instant to sampling instant are transmitted.

16. **Spread Spectrum Techniques**. Spread spectrum is a generic term applied to a signal whose bandwidth is much larger than that necessary to pass the information. These techniques, through the properties of coded modulation, can provide systems which produce low interference to other systems, have high interference rejection capability and provide multiple access capability. Although their efficiency is lower than that of frequency division or time division systems, these systems are of special interest in military communication systems because of their resistance to enemy jamming and low probability of intercept. There are three main methods employed in these systems and a particular system may employ one or more depending on the design of the system.

a. **Direct Sequence Modulation**. The digital information signal is combined with a pseudo-random binary sequence signal which has a much higher bit rate (1000 times or more) and the resultant signal is used to change either the frequency or the phase of the carrier. The bandwidth of the transmitted signal is, therefore, broadened far beyond what is needed to accommodate the information and has all the appearances of noise. At the receiver, the identical pseudo-random binary sequence signal must be used to demodulate the carrier in order to recover the original information.

b. **Frequency Hopping**. The digital information is used to modulate the radio frequency carrier in the normal manner, however, a pseudo-random code is then used to pulse the carrier frequency over a large bandwidth. A typical system might employ over 250 different frequencies with the carrier changing frequencies at a rate of 100 times per second. The receiver must employ the identical pseudo-random code in order to tune to the correct frequency at the correct instant and recover the signal.

c. **Linear Frequency Modulation (also known as "Chirp")**. A long transmitted pulse is suitably modulated and its frequency is linearly increased from F1 to F2 during the pulse duration. Only a matched receiver can demodulate the signal. This technique is often applied to radar systems but is not generally used for communications. It is, however, used in the HF band to scan the ionosphere to determine the optimum traffic frequency (called a "Chirp Sounder").

MULTIPLEXING

17. Multiplexing is the transmission of two or more signals using a common carrier wave. It enables a number of voice or other channels to be sent over a single circuit. Multiplexing systems are generally described in terms of the numbers and types of channels which they are designed to accept.

18. Common methods of multiplexing are:

a. **Frequency Division Multiplex (FDM)**. Prior to transmission, each communication channel is translated onto a unique band of frequencies within the bandwidth of the transmitted radio frequency carrier. This method is economical in bandwidth because it maximizes the number of channels which can be obtained from a radio link; it is the least complex and the most economical in frequency requirements. It is commonly used with FM or PCM. The most serious disadvantage of FDM is that the noise and signal distortion introduced in each path link of a radio system, eg, radio relay, limits the number of links that can be employed in a single system.

b. **Time Division Multiplex (TDM)**. Each communications channel is allotted a discrete time slot within the basic sampling frame and each communication is then transmitted in turn, in the allotted time slot. It is normally used with PCM. A TDM/PCM system occupies a far greater bandwidth than an FDM system of the same channel capacity but it can give better results over inferior transmission paths. It also has some advantage when two or three radio relay links are connected in series, because the pulses can be reconstituted (ie, cleaned up) after each link. The digital form of the signal is convenient for high speed automatic switching. TDM multiplexers use complex circuitry but are simple to set up and operate.

19. Sub-multiplexing is the process of combining a telegraph or data circuit with a speech circuit or utilizing a speech width channel to carry a number of telegraph or data circuits. Most sub-multiplexing equipment use FDM techniques and can be transmitted over voice channel by either FDM or TDM systems. Some TDM equipment combines both the multiplexing and sub-multiplexing functions at one terminal.

20. Multiplex and sub-multiplex transmissions employing voice frequency or radio frequency carrier may be operated over line. This is termed carrier telephony or telegraphy depending on the modes being operated. Multiplexed radio and line systems are referred to collectively as multi-channel systems.

SECTION 2

RADIO COMMUNICATION

CHARACTERISTICS OF RADIO

1. Radio communication is the transmission of intelligence through space by means of electromagnetic waves. No physical transmission path is needed, and this fact gives radio its specific advantages.

   a. **Flexibility**. Communication can be established quickly and rearranged readily. It can carry all modes of communications and be integrated with other systems.

   b. **Mobility**. Terminals are not tied to a fixed transmission path and are free to move.

   c. **Economy**. No transmission path has to be constructed.

   d. **Adaptability**. Communications can be provided across ground which is inaccessible and impassable.

   e. **Security**. Only the terminals need physical protection.

2. The major disadvantages of radio are:

   a. **Vulnerability**. Radio communication can be exploited and disrupted by enemy RECS. To obviate this liability, special communication security measures and ECCM must be adopted.

   b. **Interference**. Radio communications are subject to natural and man-made interference. Natural interference can restrict the usefulness of radio in certain physical environments and in certain parts of the frequency spectrum; man made interference can originate from other electrical or electronic equipment operated in the vicinity or on same and adjacent frequencies. Problems of electromagnetic compatibility (EMC) are getting ever more complex on the battlefield.

   c. **Range**. The power rating of radios, the nature of the ground, the propagation conditions, the propagation characteristics of the frequency band in use, all tend to limit the range over which radio communication can be provided.

   d. **Capacity**. The traffic capacity of any link is limited by the type, power and bandwidth of the radio set.

FREQUENCY SPECTRUM

3. All users of electromagnetic radiations must share one single frequency spectrum. This sharing is regulated world wide by a UN agency, the International Telecommunications Union

(ITU). By international agreement the spectrum is divided into bands, sub-bands and frequencies designated for specific purposes. From these bands, allocations and assignments are made by national authorities who are responsible for ensuring their proper use. Frequencies which are likely to be received beyond national boundaries must be coordinated internationally.

4. Within these bands, allocations are made for civilian and military purposes. In addition to frequencies for radio communications, allocation must be made for radio location, navigation systems, surveillance equipments, fire control systems and various industrial processes.

5. Despite improvements in equipment design, the ever increasing civilian and military demand for frequencies makes the task of allocating frequencies ever more complex. The difficulty is increased by the fact that certain frequency bands are more effective than others for certain purposes. In war, the enemy will also be sharing the same frequency spectrum for his own purposes.

6. The frequency spectrum is divided into the following bands:

a. **Very Low Frequency (VLF) 3-30 kHz**. This band offers few frequencies and this all but precludes its use for general communications. Parts of the band are used for long range radio navigation signalling (Omega), for frequency calibration and for sub-marine communications. The ground wave component has great penetration power and can travel in excess of 1600km. The skywave component is perfectly reflected by the ionosphere and can encircle the globe. Power requirements are high.

b. **Low Frequencies (LF) 30-300 kHz**. As for VLF, the ground wave component can reach relatively great distances. The skywave component is subject to increasing attenuation as the frequency increases but it is not affected by ionospheric disturbances like HF and is a better transmission medium in the auroral zone. Ranges from 800 to 12000 km are possible.

c. **Medium Frequency (MF) 300-3000 kHz**. This band is used intensively by civilian broadcast stations. The range of ground wave can vary from 80 km at 3000 kHz to 300 km at the lower limit of the band. Sky wave communication is unreliable during the day but at night distances of up to 5000 km can be achieved. Attenuation reaches its maximum at about 1800 kHz and varies with the season. At all times, fading is severe.

d. **High Frequency (HF) 3-30 MHz**. The range of the ground wave decreases to little more than line of sight distances. Long range sky wave communication is possible but is subject to ionospheric conditions: range will vary with frequency, day and night and solar activities. This band is used by the military for long-range communication and back up tactical radio nets. Civilian use includes radio amateurs, short wave broadcast, citizen's band and various industrial, scientific and medical users.

e. **Very High Frequency (VHF) 30-300 MHz**. There is no usable surface wave and skywave reflection in the lower part of the VHF band. This can only be achieved through sophisticated scatter techniques over ranges of 600 to 2000 km. Transmission in this band is done mostly through a direct wave which travels above the surface of the earth. The range is generally limited to line of sight, and the best results are obtained when antennas are elevated above the ground. Longer range can be obtained through a technique called automatic radio rebroadcast (RRB) in which a received signal is automatically retransmitted on a different frequency by the second radio of a rebroadcast station specially sited for this purpose. This band is used by the military for CNR and by civilians for FM radio and TV broadcast and air traffic control. Radio communication in this band is free from noise and interference, provides good speech quality and is reliable 24 hours a day over suitable terrain.

f. **Ultra High Frequency (UHF) 300-3000 MHz**. Except for the lower part of this band where troposcatter reflection can achieve moderate ranges, communication is near line of sight. Lack of interference and fading generally affords high quality reception. Compact and directive antennas can concentrate the radiated energy in a narrow beam resulting in much greater transmission efficiency. The military use this band for air to ground communication, for radio relay transmission and for some satellite links. Civilian use includes TV broadcast, some industrial usage and satellite navigation.

g. **Super High Frequency (SHF) (3-30 GHz)**. This band offers many times the information carrying capacity of all lower bands put together. Throughout this band, wide band communications are obtained over line of sight paths with very low power. The reduced size of the antenna permits this form of transmission from aircraft or satellite, enabling global ranges to be achieved by retransmission. Transmission in this band are subject to atmospheric absorption and will be affected by weather; ie, rain, fog, etc.

h. **Extremely High Frequency (EHF) (30-300 GHz)**. This band is also known as millimetric waves. Tropospheric, ionospheric and atmospheric absorption is severe in this band and circuits must be carefully engineered. Once established, these circuits offer high reliability and very wide bandwidths capable of large volumes of traffic. Ground range is normally limited to a few kilometers making enemy interception or jamming difficult, except when satellite or aircraft platforms are used. This band permits use of small dish antennas. The full capability of this band is still not fully exploited. In addition to satellite communication, the army could use this band for intra-HQ communications.

j. **Decimillimetric waves (300-3000 GHz)**. Imagery, target acquisition, surveillance devices and thermal sensors operate in this band. Atmospheric absorption is most severe in a humid or moist environment and ranges are reduced in fog and rain.

k. **Optical (400-800 tHz)**. Fibre optics transmission is done in this band. Attenuation is proportional to the degree of impurities found in the core of the transmission cable. Interference and interception is easily detectable. Laser devices can also be used to transmit light signals. Developments in laser technology may result in range finding, telecommunication and weapon control equipments for the military.

RADIO PROPAGATION

7. **Propagation Paths**. There are two principal paths by which radio waves can travel from a transmitter to a receiver: by ground wave or skywave. All radio transmissions use one or both of these paths or various associated phenomena.

8. **Ground Wave**. Ground waves travel more or less directly from the transmitter to the receiver (see Figure 3-1). This form of propagation is affected by the electrical characteristics of the ground and by the amount of diffraction, or bending, of the wave around the curvature of the earth. The components of the ground wave are:

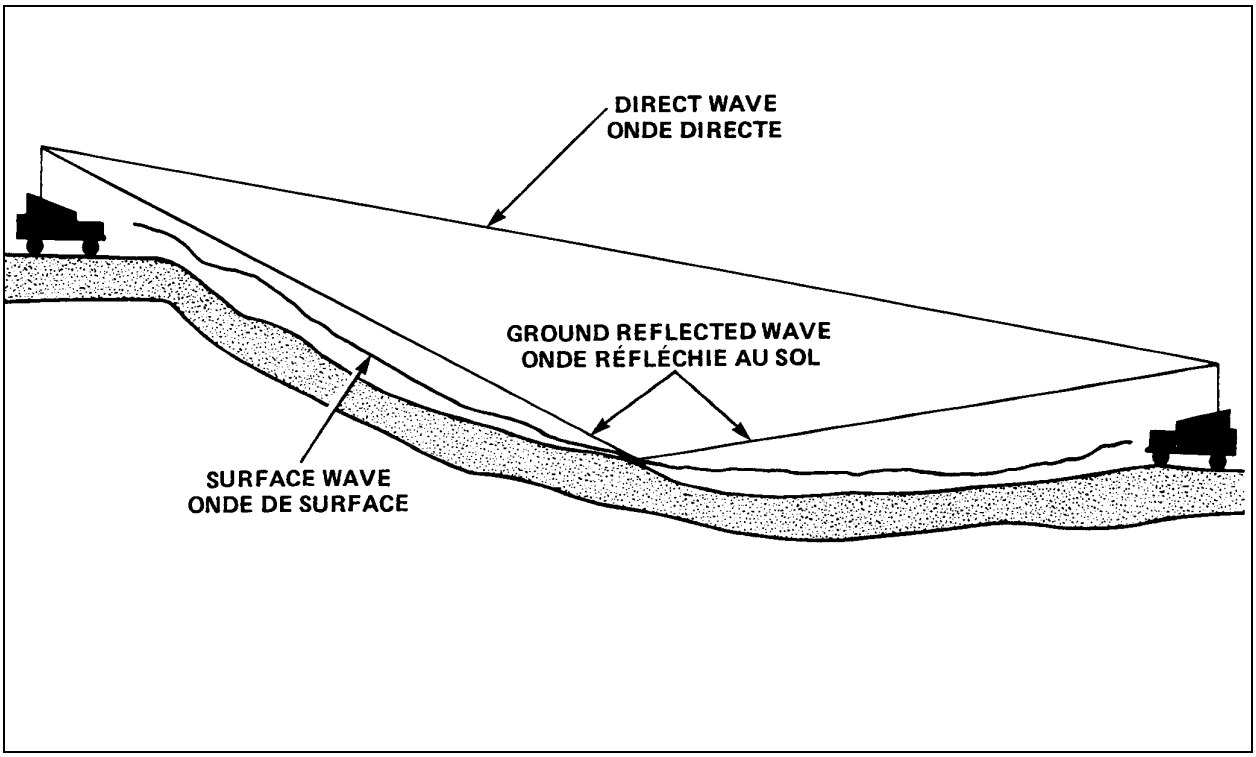

Figure 3-1 Ground Wave Transmission Paths

a. **Direct Wave**. This component travels directly through space from the transmitting to the receiving antenna. On the ground, range is limited to the line-of-sight distance plus the small distance added by atmospheric refraction diffraction of the wave around the curvature of the earth. The range can be extended by raising the height of the antenna above the ground. Range is also

affected by antenna gain, the power of the transmitter and the sensitivity of the receiver.

b. **Ground Reflected Wave**. The ground reflected wave is the portion of the direct wave that reaches the receiving antenna after being reflected from the surface of the earth. When both the transmitting and receiving antennas are on, or close to the ground, the direct and ground reflected components tend to cancel each other.

c. **Surface Wave**. This component travels in contact with the ground and follows the curvature of the earth. The surface wave predominates at frequencies below 30 MHz and relatively long ranges can be expected over areas of high conductivity. Wave dissipation or attenuation is greatest over jungle and desert and is least over sea water. Although surface waves tend to follow the contours of the ground, obstacles such as hills gradually attenuate these waves by reflection, scattering, and absorption.

9. **Sky Wave**. The second path over which radio waves can travel is through ionospheric reflection (see Figure 3-2). These waves travel up to the ionosphere and are reflected back to earth. Long distance transmission is achieved principally by the use of sky waves at HE For very long ranges, (beyond 4000 km) transmission may take place by successive skips from the ionosphere and the earth's surface (multi-hop transmission). There are, however, some special considerations in achieving a sky wave path. Above 30 MHz, sky wave working is generally impossible. Furthermore, for any given path there are critical limits to the frequency and to the angle at which the wave must strike the reflecting medium (angle of incidence). The optimum frequency depends on the geographic location of, and the distance between the transmitter and receiver, the time of day, and the season of the year. The path and angle of propagation determine to a large extent the type of antenna that must be employed. Depending on its frequency and the angle of attack, the reflected sky wave may return to a point lying within the range of the ground wave, or beyond it. In the former case, severe distortion of the received signal may result from the alternating reinforcement and cancellation of the two incoming waves. In the latter case, no signal will be received between the limit of ground wave reception and the point at which the sky wave returns to earth. The area in which no signal is received is termed the skip zone. Despite these limitations and except for periods of severe ionospheric disturbances, skywave working can be a useful method of communication.

10. **Forward Scatter Reflection**. In addition to the relatively efficient reflection that can be achieved by a sky wave at HF, a much weaker reflection and scattering phenomenon occurs at considerably higher frequencies. Unlike sky wave reflection, which takes place only in the ionosphere, scattering takes place throughout a large volume of the atmosphere and at some depth causing the propagated wave to diffuse widely. The signal arriving at the receiver, therefore, is the sum of a large number of very small signals. As a result the signal strength is constantly varying with rapid short term seasonal and daily variations. Communications employing this path require high power transmitters, complex receivers, and high gain directional antennas. There are two forms of scatter transmission in wide use:

a. **Ionospheric Scatter**. Ionospheric scatter operates in the frequency range of 25 to 60 MHz. It is a relatively narrow band method used to provide communications over ranges extending to 2500 km. The range, coupled with the size of the transmitters and antennas used in this mode of transmission, preclude mobility; it is therefore reserved for strategic links or for links between the rear of the combat zone and the communication zone.

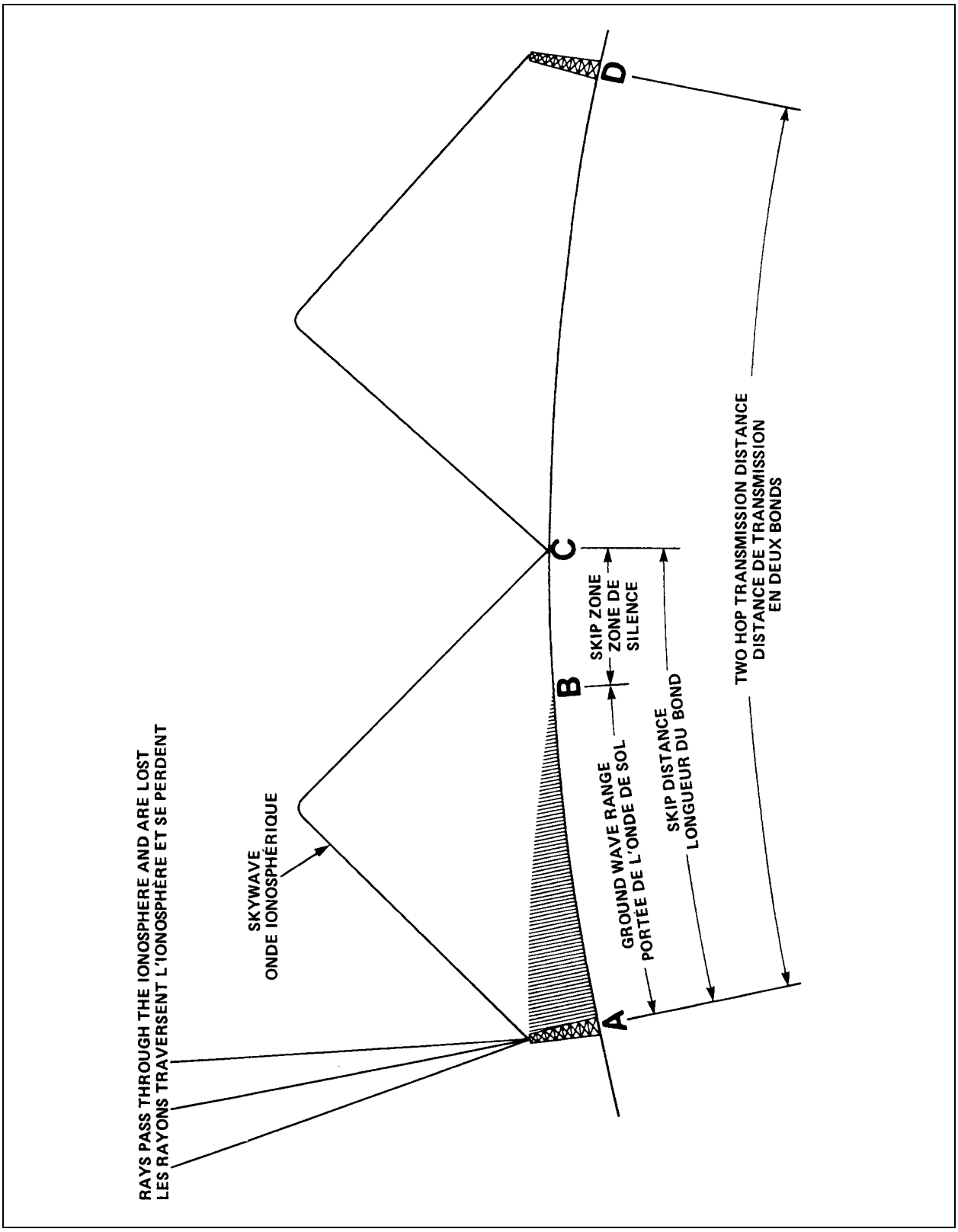

Figure 3-2 Transmission Paths

13. **Directional Antennas**. In the field army, directional antennas are used for skywave working at HF, for all scatter modes of operations and for radio relay. Directivity obviously is more technically efficient but it also provides protection from enemy interference when antennas are properly sited.

14. More information on specific types of antennas can be found in B-GL-321-006/PT-001.

COMBAT NET RADIO (CNR) SYSTEMS

15. **Radio Nets**

a. A combat radio net consists of a net control station and a number of substations. Radio rebroadcast (RRB) stations may also be employed to extend the operating range. The net control station, normally found at the senior HQ, controls the traffic and enforces circuit discipline. Sub-stations are either attached to a subordinate or adjacent HQ or to key personnel for movement away from HQ.

b. A radio detachment or station consists of the combat net radio (CNR), the crew and the ancillary equipment including vehicles, tents, generators, etc. Stations may be manpack, vehicle-borne or mounted in aircraft. Depending on their tasks, detachments may be equipped with one or more radios to protect one or more nets; some key detachments may have radios to protect guard nets on alternate frequency bands.

c. All transmissions on net radios are simplex, that is, no more than one station can transmit at any one time. In principle, all stations hear all messages passed on the net.

16. **Characteristics**. CNR systems share the characteristics of all radio communications described at paragraphs 1 and 2 of section 2. Some additional peculiarities deserve special emphasis.

a. The great flexibility of CNR systems and their instantaneous responsiveness is counterbalanced by their limited traffic bearing capacity. There is also a practical limit to the number of stations on a net.

b. Nets are vulnerable to enemy electronic support measures (ESM) because they tend to reflect in detail the organization of the force being served. Despite communication security measures, net operation may disclose the type of formations/units, the order of battle and give indication about friendly intentions/operations. The presence of a cluster of stations operating on several nets at a particular location facilitate identification and direction finding.

c. Nets are vulnerable to enemy electronic countermeasures (ECM) (jamming and deception) in both the VHF and HF bands. Net discipline must be strict, ECCM drills well rehearsed and communication security procedures continually enforced.

On-line signal security equipment must be used whenever provided; in their absence, users must be familiar with other measures such as off-line ciphers and voice codes.

17. **Application**. Because of their characteristics, nets are particularly suited to the operations of tactical groups at brigade level and below where instantaneous acknowledgement and reaction is essential. The distribution of CNR equipment facilitates regrouping as tactics require and passage of information between nets is made possible by the provision of multiple radio stations at specific HQ.

18. **Frequency Coverage**

a. The most suitable frequencies for CNR systems are in the HF, VHF and UHF bands. Current sets used by ground forces operate in the bands from 1.5 MHz to 400 MHz. Although radios can be designed to operate on a fixed frequency the requirement for flexibility and ECM protection demands that these sets be capable of tuning over a broad range. Since net radios with wide frequency coverage tend to be expensive, individual radios each cover only a part of the band. For flexibility, therefore, a radio station requires two or more sets, usually an HF and VHF combination, with a consequent weight and size penalty. Radios with much broader frequency coverage and capable of more than one form of modulation are justifiable however for special roles, eg, long range patrols.

19. **Operating Modes**

a. CNR can be used to provide several modes of operation: voice, telegraphy (Morse code), teletypewriter, and data are possible modes, but voice is the primary mode of operation on CNR.

b. Morse code is employed on HF nets where distance, terrain or interference preclude normal voice transmission. At VHF, integration because of the abrupt attenuation of signal and the peculiarities of FM, no such advantage exists and Morse code is not employed.

c. With the addition of ancillary equipment, most types of CNR can also be modulated with a teletype signal. Radio teletypes are provided for links over which a large volume of message traffic must be handled. Generally, HF radio is modified for this form of operation so as to achieve greater ranges.

d. Ancillary devices are available that permit the transmission of data over a voice net. They afford a fast method of transmitting short fixed format messages. This equipment is provided as an additional facility and not normally for simultaneous operation with voice; however, forms of burst transmission operations may be adapted to CNR in the future.

20. **Facilities**

a. **Remote Control Unit (RCU)**. The use of an RCU allows an operator or a user to be located at a distance from the radio. RCUs for CNR allow all basic functions, eg, transmitting, receiving and various other functions to be carried out from a remote site. An operator may be still needed at the radio to tune or adjust the set. Normally the antenna used in CNR cannot be sited at any distance from the transceiver.

b. **Radio Wire Integration (RWI)**. A switched telephone system may be interconnected with a CNR system through radio wire (RWI) facilities. This facility enables static telephone subscribers to communicate with mobile users through the telephone switchboard.

c. **Rebroadcast**. Rebroadcast is a method of extending the range of a radio net by using an intermediate station. Rebroadcast may be automatic, in which case two transceivers are employed back-to-back, each operating on a different frequency (retransmission); or it may be manual, in which case retransmission is performed by an operator on the common or net frequency (relay). Two transceivers connected with a suitable harness may permit either manual or automatic rebroadcast stations to be employed to extend the range of radio nets.

d. **On-Line Encryption**. Signals may be automatically encrypted and decrypted by the use of on-line security equipment. On-line cryptographic equipment, properly installed and operated, will provide security of information. The keying of material must be done locally or remotely according to formation communications electronics standing instructions (CESI).

RADIO COMMUNICATION BY SKYWAVE

21. **Links**

a. Within an area of operations, certain user communication requirements cannot be served by net radio for a variety of reasons which could include the traffic volume, the distances between users or the identity of the users.

b. A link is a communication path of specified character between two points. Link communication can be achieved through skywave HF radio, scatter radio or satellite. Only HF skywave radio will be dealt with in this paragraph; scatter radio or satellite will be described later.

22. **Characteristics**. Skywave radio generally shows the characteristics of all radio communication described at paragraphs 1 and 2 of section 2. Some specific aspects deserve mention.

a. **Capacity**. A link is operated in the duplex mode whenever possible so as to provide enhanced traffic carrying capability as compared with net radio; this may not always be possible however. In the HF band, capacity is mainly improved by increasing transmission speed.

b. **Mobility**. The need for a number of elaborate and large antennas seriously limits the mobility of this type of station. Once installed, the station cannot be moved without an interruption in its communications.

c. **Signal Security**. Because of the often unpredictable range of sky wave transmission, considerable attention must be paid to security. High grade encryption is required to protect adequately the information passing over such links.

d. **Vulnerability**. Sky wave radio is vulnerable in the following ways:

(1) the extensive antenna parks generally required for this type of operation are readily distinguishable by aerial or ground reconnaissance and provide inviting targets;

(2) the requirement to operate these links within narrow and predictable frequency limits renders these systems very vulnerable to detection, and, consequently, to jamming or direction finding; and

(3) **EMP**. Post nuclear atmospheric disturbances would black out these links for some time.

23. **Application**. Skywave radio is normally used for:

a. rear links from the area to national HQ;

b. operational and administrative links at the area, army group and corps level; and

c. communications to long range patrols and to forces engaged in special operations.

24. **Choice of Frequency Bands**

a. HF is the normal method of providing these communications although low frequency (LF) or medium frequency (MF) may be employed. The frequency selected depends on the availability of suitable radios and frequencies, the geographic location, path length, and ionospheric conditions.

b. Frequencies chosen for this form of transmission are based on estimates of path performance provided by prediction tables or computer calculations. Although generally dependable these estimates are no guarantee of continuous and reliable

operation. Several frequencies are generally required for long term, day and night, all season operation.

c. In Arctic latitudes, LF is a preferred frequency band.

25. **Operating**. Operating modes could include radio teletype, voice, slow data, or Morse code. Facilities afforded the user are mostly a function of the bandwidth available, the speed of transmission possible and the mobility required.

26. **Facilities**

a. **Remote Installation**. Terminal equipments may be located away from the radio station in which case mobility is further restricted. Costs in operating personnel are higher as both the radio and the remote sites must be manned.

b. **On-Line Encryption**. Normally data and voice signals will be automatically encrypted and decrypted by use of on-line security equipment to provide security of information.

RADIO COMMUNICATION BY FORWARD SCATTER

27. **General**. Signals may be transmitted to distances beyond the line of sight by a form of transmission known as forward scatter. Tactical communication systems use tropospheric scatter transmission to obtain wide band channels at medium ranges from 100 to 1000 km.

28. **Characteristics**

a. **Reliability**. Tropospheric scatter provides generally reliable communication over ranges that cannot be obtained with radio relay or by HF sky wave transmission. The quality of scatter circuits approaches that obtained by line-of-sight methods and is better than HF skywave.

b. **Economy**. For distances over 100 km it is generally more economical in resources than radio relay.

c. **Flexibility**. Some degree of flexibility is possible in establishing these links. For a given power output and antenna, bandwidth can, to some extent, be exchanged for increased range, ie, the range of the link can be increased by reducing the number of channels.

d. **Capacity**. Tropospheric scatter utilizes a less congested and higher portion of the frequency spectrum, making wide band transmission possible.

e. **Vulnerability**. Tropospheric scatter is vulnerable for the following reasons:

(1) the wide diffusion of the signal renders it susceptible to interception or jamming;

(2) the nature of the installation, eg, type of vehicles and number of antennas, and the need to site in relatively open ground make it vulnerable to enemy observation and attack; and

(3) it is susceptible to EMP effects.

f. **Signal Security**. Classified traffic passed over this form of transmission must be protected by cryptographic equipment.

g. **Transmission Path**. Tropospheric scatter has two major limitations:

(1) Path losses for this form of transmission are high and these losses increase greatly with range. Furthermore, because of multi-path effects, some of the transmitted frequencies are more seriously attenuated than others. This effectively reduces the bandwidth that may be transmitted. Greatly increased power is needed to compensate for these differential path losses at the longer ranges.

(2) The received signal is subject to rapid and long term fading caused by daily and seasonal atmospheric changes. Specialized propagation techniques and very sensitive receivers must be employed to overcome this fading.

h. **Siting**. Siting requirements for tropospheric scatter stations are stringent. Because of the high power employed to propagate the narrow beam signal, there is a radiation hazard in the vicinity of the antenna. The danger area in front of the antenna may be extensive, as the beam must usually be aimed at a nearly horizontal angle to obtain the desired ranges. Two, and sometimes four, parabolic antennas are required at each site for each path link. Therefore, areas for siting such stations must be larger than those employed for other forms of transmissions, and no obstacles can be tolerated in the direction of the signal.

j. **Response time**. Prediction methods for establishing tropospheric scatter circuits tend to be somewhat inexact compared to methods used for other forms of transmission, and circuits must be developed largely by trial. Sufficient planning time must be allowed for the establishment of reliable links.

29. **Application**

a. Tropospheric scatter provides radio communications at ranges not covered by line of sight VHF, UHF, or SHIP equipment, and impractical for HF equipment. By this method single hop, high capacity communications can be provided over difficult or hostile terrain and obstacles. However, it is for the transmission ranges

of from 100 to 600 km that cannot be efficiently covered by other types of tactical radio that this form of transmission finds its greatest utility.

b. Tropospheric scatter is normally operated as a wide band system for medium length trunk paths. Back-to-back operation with other scatter stations, or with line-of-sight radio relay equipment can be readily accomplished to further increase the range. If required, scatter stations can be employed in a line-of-sight mode on much less power.

30. **Frequency Band**. Tropospheric scatter operates in the frequency band of approximately 300 MHz to 10 GHz. For tactical use, frequencies from 3 to 5 GHz are used providing up to 24 voice channels. For the longer ranges needed in strategic applications, lower frequencies, eg, 0.5 to 1 GHz are employed.

RADIO COMMUNICATION BY SATELLITE

31. General

a. Satellite transmission provides radio communications between two or more terrestrial points via a repeater located on a spacecraft.

b. A spacecraft repeater in geosynchronous orbit (36,000 km above the earth) will appear to be stationary with respect to the terrestrial terminals and can be accessed from anywhere in an area of one-third of the earth's surface. The terminal can be fixed or mobile and the transmission path extends from the earth's surface to the spacecraft and back, the quality of transmission is the same whether the ground terminals are close or far apart and is not affected by the intervening terrain between them.

c. Spacecraft in lower orbits can be used, however, they will appear to move across the sky and, therefore, the terminal antennas must have a capability to track the satellite. As the satellite moves out of visibility both terminals must reorient their antennas to a new satellite moving into their view. A constellation of five to seven satellites will be required to give continuous large area coverage.

d. Satellite communication systems can provide high quality speech, teletype, data and television channels. Tactical communications systems utilize satellites to obtain wide bandwidth transmission at extended ranges over terrain not otherwise accessible.

32. Characteristics

a. **Flexibility**. Satellite communication is a flexible method for providing all types of communication requirements found on the battlefield. Flexibility is limited only by the number of terminal equipments and satellite stations available.

b. **Mobility**. Forward area satellite terminals are highly mobile, and can be either man portable or installed on tactical vehicles.

c. **Economy**. Satellite communication terminals are just as economical to operate as other communication terminals of equivalent capability. However the space segment is very expensive and very few nations can afford to have satellite communication systems for military purposes despite their undoubted efficiency.

d. **Vulnerability**. Satellite communication is vulnerable because:

(1) there is a danger of losing satellites and thus of suffering irreparable damage to operational communications systems;

(2) it is susceptible to damages caused by EMP;

(3) it is susceptible to intercept and jamming, unless hardened to military specifications; and

(4) satellite control could be seized by enemy forces unless specific countermeasures are used.

e. **Signal Security**. Traffic over all channels can best be encrypted by using on-line bulk encryption devices. These may be located at ground terminal stations and at switching facilities as required to ensure security of transmission between subscribers. All classified traffic passed by this form of transmission must be protected by cryptographic equipment.

33. **Application**

a. Low capacity, man portable terminals, capable of speech as well as data transmission in a secure mode are available. These enhance communications on the battlefield especially in the forward area and over difficult terrain.

b. Medium capacity tactical satellite terminals can be advantageously used in all types of conditions. High ground is not a requirement provided that direct line of sight paths can be established and maintained. Terminal stations are easily transportable by vertical take-off and landing aircraft.

c. Satellite communication systems can form part of the area trunk system. Interconnecting links are required to permit integration of systems and/or to provide communications to the supported headquarters or local signal facility.

34. **Frequency Band**. Satellite communication systems utilize the UHF, SHF and EHF bands. Use of available frequencies and channels is controlled at the highest level.

RADIO COMMUNICATION BY RADIO RELAY

35. Radio Relay

a. Radio relay describes a form of wide band radio transmission employing line-of-sight paths for point-to-point or link communication.

b. A radio relay system consists of two terminal stations communicating with each other directly or through one or more repeater stations. Repeater stations possess duplicate radio equipment to enable tandem operation. Combinations of these basic installations allow a variety of system and circuit interconnections.

c. Depending on the type of equipment, radio relay systems can provide a set number of high quality speech and data channels, or a lesser number of video channels.

36. Characteristics

a. **Flexibility**. Radio relay is a much more flexible method of providing multichannel communications than line or scatter systems. However, its flexibility depends greatly on the number of stations that are available to step up and relay. When available, radio relay can be readily relocated, extended, and rearranged to conform with changing tactical requirements.

b. **Mobility**. Radio relay cannot be operated on the move. It is, however, readily transportable by vehicle. Helicopters may be used to move stations over impassable terrain or to otherwise inaccessible sites. Once on site it is reasonably quick to set up and tear down.

c. **Economy**. For average path ranges, radio relay is much more economical in resources than the other methods of providing multi-channel communications. However, its greatest advantage is that, provided suitable sites are available, additional links can be interconnected, with the deployment of few additional stations. It is thus possible to provide a communication grid economically; a feature less easily accomplished using other methods.

d. **Reliability**. Radio relay is virtually immune to atmospheric interruption and enjoys a drastically reduced susceptibility to interference from other emitters. The relative ease with which a grid can be established greatly enhances the opportunities for alternate routing. Equipments are easy to operate and maintain, circuit paths can be predicted with a high degree of assurance and, once engineered, circuits are extremely stable.

e. **Vulnerability**. Radio relay is vulnerable:

(1) It is necessary to site stations within line of sight either on high ground or in isolated positions; radio relay stations are thus relatively easy to target. This can be reduced by proper tactical siting of detachments and careful shielding of paths from enemy observation.

(2) Radio relay is less susceptible to interception, direction finding, and jamming than other forms of radio because it employs highly directional antennas in a ground-to-ground mode. There is, however, a risk that the detection of a number of signals from a single radio relay node in a narrow arc will disclose not only the communications grid but possibly the formation axis.

(3) It is subject to EMP.

f. **Signal Security**. Although the low power of equipment and the effects of screening by terrain greatly reduce the range of useful intercept, interception is still possible and traffic must be protected. Traffic over all channels can best be encrypted by using on-line, bulk encryption devices.

37. **Application**

a. Low capacity radio relay sets designed for forward area use generally have the associated multiplexing equipment as an integral feature of the installation. In higher capacity stations designed for rearward applications, installation of the radio relay set and the associated multiplexing equipment may be separate depending on size and capacity.

b. Because of its characteristics, radio relay is used as the main transmission system for tactical area communication systems used at formation level in the combat zone.

38. **Frequency Band**

a. The wide bandwidth employed in radio relay necessitates operation in the VHF, UHF, or SHF bands.

(1) At VHF it is still possible to work beyond the optical path and with relatively narrow margins of path clearance. In this frequency range the methods of predicting usable circuits are well established and comparatively simple. Because of the less demanding characteristics, VHF is much more suited to tactical use, particularly for forward area applications. Unfortunately the congestion in this band does not always afford the large number of frequencies needed for an area radio relay system.

(2) At the upper VHF (225-300 Mhz), and within the UHF and SHF bands, the path is virtually line-of-sight and transmission quality is excellent provided Fresnel zone clearance is provided.

b. A radio relay system requires a large number of frequencies over a broad band. Circuits are normally duplex, and adjacent links must be established with broad frequency separation. At junctions, links of adjoining systems require a similar separation of frequencies. Because of the zigzag course usually followed by radio relay links, dissimilar frequency lists may be needed for nearby parallel links if interference is to be avoided. It is normal to use computer assistance for frequency assignment, path loss calculation and siting of stations.

SECTION 3

LINE

LINE COMMUNICATION

1. This is a form of communication in which there is a physical connection between the transmitter and the receiver. The most usual means of connection is the metallic wire, the coaxial cable or the wave guide. Metallic wires may be single, or grouped in pairs or pair multiples to form multi-core cable. Coaxial cables are especially designed for transmission at radio frequencies.

2. Fibre optic cables can also be used for line communications. In this case the connection is a clear plastic fibre and the information is passed by modulating a light beam which is transmitted over the fibre. The major advantages of fibre optic cables over metallic cables are:

   a. the cable is lighter and smaller;

   b. it is immune to electromagnetic interference including EMP; and

   c. it has a bandwidth up to 100 times greater than that of a metallic cable of the same size.

3. Line systems are classified according to the degree of permanence inherent in the installation as field or permanent line systems. Field line systems are characterized by ruggedness, simplicity, and ease of installation and removal. Permanent line systems tend to be more complicated, must be individually planned and built, and take time and heavy equipment for construction.

4. Line communication systems can be laid over the ground, suspended on poles or towers, buried or submerged.

CHARACTERISTICS

5. **Flexibility**. Line communications are relatively inflexible in the context of military operations. Once laid to support a specific configuration of forces, they require a lot of work to adjust to a change in troop disposition or requirements. This is particularly true in the forward combat zone. The construction of line takes time, a fair amount of manpower and considerable amount of stores which increase with distance. Therefore distance, frequency of moves and response time are critical factors to be considered before deciding on line as a means of communications. On the other hand, it can be used during electronic or radio silence and is not constrained by radio frequency allocation.

6. **Capacity**. Line communications can provide a very high traffic capacity. They provide a stable and high quality transmission path which can be built up as required. The operating range of line communications vary according to the characteristics of the cable and terminating

equipment, and the method of construction. Field cable is affected by wet weather conditions and wear and tear (damaged insulation and excessive splicing). Range may be extended by the use of line repeaters.

7. **Economy**. Line construction is expensive in time, manpower and materiel. Once installed, line communications are relatively easy to maintain, except in the forward combat zone; they are also operated with relatively few personnel. Unlike radio communications, subsequent increases in capacity result in very modest increase in personnel and equipments.

8. **Vulnerability**. Line communications are vulnerable to deliberate or accidental damage throughout their length. This is even more so in the forward combat zone because of enemy action, friendly troop movements and the method used for line construction. Line construction or maintenance crews must work along exposed routes, at times without cover or concealment and are subject to shelling, strafing and ambush. Line routes must be patrolled and line crews must be capable of fighting in self defence. Metallic wire and cable lines are also subject to EMP.

9. **Signal Security**. Line is immune to most forms of ECM and signals emanating from it can only be detected at close proximity. It is thus a valuable alternative to radio in the preparation stages of an operation or under conditions of electronic or radio silence. Provided line routes are regularly patrolled, its use in friendly areas provides a relatively secure means of communication.

APPLICATION

10. Line communications are best used where mobility is not a paramount requirement but where high capacity and signal security are essential.

11. In the forward combat zone, field line communications will be used in periods of radio and electronic silence, in the preparatory stages of offensive operations, as long as possible during defensive operations and at all times within unit or formation HQ. Specific usage will be to provide combat information exchange within staff cells of a HQ, to connect a HQ to the area communication system, to provide remote facilities for CNR and to provide an inter-unit line grid in the absence of radio communication.

12. In the rear combat zone and the communication zone, line communications will gradually become the main stay of communications as distances from the enemy increases, as communication requirements become more permanent, more complex and more dense and as mobility of users becomes a less important factor. In a lot of cases, line communication will be integrated into area communication links to form hybrid radio and line systems where the advantages of both techniques will be exploited fully.

MODES OF OPERATION

13. All electrical and electronic modes may be employed with line. Telephones may be combined with teletypewriters over most types of field cable. Alternatively, a number of teletype circuits can be transmitted at voice frequency over a single field cable.

14. Multiplex signals may be transmitted at radio frequency over line. A higher grade of field cable, eg, carrier quad, or a fixed line system is required for this form of transmission. Such a line must be constructed to suitable standards and requires repeaters and equalizers inserted at regular intervals throughout its length. This type of line system normally forms part of an area multi-channel system.

15. TV and high speed data circuits which occupy a very wide band are transmitted over coaxial cable. Line losses and problems inherent in amplifying this type of signal limit the length of these lines for field applications. However the advent of field grade fibre optics cable will render this possible in the short term.

SECTION 4

HAND CARRIAGE

COMMUNICATION BY HAND CARRIAGE

1. Hand carriage describes a physical means of communication in which signal traffic is manually taken between headquarters, and in certain cases between originators and addressees.

2. The common methods of carriage consist of runners on foot (within HQ only) and despatch riders on motorcycles or wheeled vehicles (signals despatch service or SDS). When available, aircraft, boats, trains, or any other form of transport may be used for this purpose. Formations and units provide these communications to subordinate and lateral headquarters.

3. In addition a courier system is usually employed to carry important classified traffic or documents to, from or within an area of operations. Within an area couriers are generally detailed as required to carry traffic directly between originators and addressees when the security classification precludes it being sent through the normal SDS.

CHARACTERISTICS

4. **Flexibility**. This is a very flexible means of communication which can be readily adjusted in terms of timings, destination, frequency and according to the needs of the moment. It requires little specialized training.

5. **Capacity**. Carriers can transport a sizeable amount of information depending on their mode of transport. This is offset however by their relative slowness and the fact that each carrier must reach each addressee in turn. Speed is a function of the mode of transport, distance, terrain, weather, routes available and the tactical situation.

6. **Economy**. This method may be relatively costly in personnel but under difficult warfare conditions it is an effective method of passing critical messages/information.

7. **Vulnerability**. Carriers are not subject to EW but are as subject to physical destruction as other combatants at the same tactical echelon. In the forward combat zone there is danger of ambush by enemy infiltrated parties.

8. **Signal Security**. This is probably the most secure means of communication available to commander and staff.

APPLICATION

9. Hand carriage serves to complement the other means of communications. It can be used for:

a. transmission of message traffic that cannot be passed by electronic/electrical means by reason of its security classification or its format. The latter includes lengthy messages, bulky documents, large charts or maps;

b. communications within sub-units or for minor elements or installations within subunits or for minor elements or installations within an area which lack other means of communication;

c. collection of traffic within a headquarters or between components of a headquarters;

d. message traffic when the other means of communication are inoperative or are reserved for higher priority traffic; and

e. transmission of data in the form of computer tapes or discs.

10. Common user hand carriage may be scheduled or unscheduled. When it is scheduled, it is called SDS. It is provided when the quantity of traffic between HQ and units warrants it. When it is unscheduled, it is called Special Despatch Riders (SDR) service and is provided when unforeseen requirements arise.

11. On the high intensity battlefield, in the face of heavy enemy RECS interference, this means of communications may well be critically important in the forward combat zone.

CHAPTER 4

THE STRUCTURE OF TACTICAL COMMUNICATION SYSTEMS

SECTION 1

REQUIREMENTS

FACTORS

1. The need for tactical communications was defined in Chapter 1 and the various technical means available were described in Chapter 3. It remains to explain how these various means are regrouped into systems to satisfy the needs of the users.

2. Before effecting the regrouping of the various means into effective tactical communication systems, the following factors have to be considered:

a. **Interoperability**. A system must allow the user to communicate with any other user with whom he is required to communicate. Systems must therefore be integrated with one another and allow for smooth passage of information from one system to another whenever possible.

b. **Survivability**. Each system has to provide a reasonable degree of assurance that it can fulfil its intended function in spite of physical or electronic attacks. All systems together must provide the accepted degree of resilience and capability to withstand enemy attack.

c. **Security**. Each and all systems must provide the required degree of signal security for user traffic.

d. **Capacity**. Each system must provide the required traffic capacity for its intended use. In particular, the speed of transmission must correspond to the traffic urgency. The modes of communication have to satisfy the functional requirements of the users. The system must be able to handle average traffic loads and planned peak loads as well as being able to cater to single and multiple address traffic.

e. **Flexibility**. The system must be able to adjust within limits to changing requirements and to the tactical and physical environments.

f. **User Orientation**. The system has to be structured so as to facilitate rapid and easy access by all intended users despite continuous grouping and regrouping of forces.

STRUCTURE

3. The above factors have led to the structuring of the various means of communications into three major tactical communication systems: CNR systems, trunk communication systems and SDS.

4. Each system is present in varying degree and form at the different levels of command. Each forms part of the overall tactical communication system which serves the command and control function.

5. Depending on the function or the importance of the users, elements of these systems may be provided on a common user or a dedicated basis. Common user facilities are the preferred method of handling most traffic between formations, units and individuals. But sole user facilities are allocated for specified functions and appointments.

SECTION 2

COMBAT NET RADIO SYSTEMS

EMPLOYMENT

1. CNR systems are described from a technical point of view in Chapter 3, section 2, paragraphs 15 to 20. The following paragraphs discuss their specific employment on the battlefield.

2. CNR systems are the primary means of communication at brigade and unit level in the forward combat zone. This includes both all-arms brigades and single-arm/service brigades such as artillery brigades, engineer groups, aviation wings and service groups, etc. At division level CNR systems remain an important back up communication means; at corps level, it is largely replaced by the single channel radio access (SCRA) element of the trunk system and subsists only for a few important combat functions.

FUNCTIONAL ORGANIZATION

3. Radio nets are designated in terms of the combat function served. These are:

a. **Command**

(1) Command nets are established for each level of command from division to platoon/troop headquarters, or even sections or detachments. This includes all arms headquarters as well as single arm/service headquarters. In the absence of dedicated facilities for other combat functions, command nets also serve these other functions.

(2) On the high intensity battlefield, special nets are organized to communicate damage and radiation reports. Broadcast stations are employed to warn friendly forces of own or suspected enemy NBC strikes and to transmit other information of an urgent operational nature.

b. **Combat Intelligence**. Under certain circumstances, at division and higher levels dedicated nets may be established to handle intelligence traffic. Below division, command nets serve this purpose.

c. **Artillery Nets**. These nets are organized to communicate target information, to request fire support and to co-ordinate artillery matters.

(1) **Artillery Command Nets**. These nets exist to communicate target insformation to appropriate fire support agencies. Artillery units in the direct support role provide these communications by extending command nets to artillery observers controlling the fire. A number of specific nets must be formed when fire support is furnished by another command, eg,

naval task force, or area air force. In an emergency any net providing suitable communications may be used to request fire.

(2) **Artillery Meteorological Broadcast Nets**. Meteorological messages are broadcast at regular intervals for purposes of artillery fire and air support.

(3) **Artillery Intelligence Nets**. These nets are used for the transmission of artillery intelligence and target information gained mainly by artillery target acquisition elements.

(4) **Air Defence Early Warning Nets**. These nets provide the means of passing contact information and detection from air defence surveillance agencies to the headquarters controlling the air defence units.

(5) **Air Defence Control Nets**. These nets are used by air defence headquarters to direct and co-ordinate the engagement of hostile aircraft or missiles by air defence units or elements.

d. **Electronic Warfare Command Nets**. These nets are used to direct formation EW elements and to pass EW information to supported formation headquarters.

e. **Air Nets**. These nets are organized as follows:

(1) **Tactical Air Direction Common Nets (TADC)**. These nets are organized to communicate with incoming fighters ground attack (FGA) in flight and to pass in-flight reports (eg, post-strike reports) from the outgoing aircraft to the tasking agency (ie, tactical air control centre (TACC) or an air support operations centre (ASOC)).

(2) **Tactical Air Direction Nets (TAD)**. After handover from the TACC or ASOC on the TADC frequency, forward air controllers (FACs) will use these nets to direct aircraft onto targets. Interested headquarters may monitor these nets.

(3) **Air Request Nets**. These nets are established at formation level to request immediate air support; they link the formation headquarters controlling close air support with the supported tactical elements. Intervening formation headquarters monitor these requests to allot priorities or to veto. Requests for planned air support are transmitted over command nets.

(4) **Tactical Air Information Nets**. These nets can be set up to pass the results of close air support missions from the tasking headquarters back to the headquarters requesting the mission. These nets are usually provided when air support is centralized at a high level.

(5) **Air Traffic Control Nets**. These nets are used to ensure that friendly aircraft may safely enter, manoeuvre in, and depart from own areas of operation without hazard from friendly forces. Tactical air traffic control, tower and ground control approach, and air movement information nets are examples of these communications.

f. **Administrative Nets**. Administrative nets are established at lower formation levels to interconnect the administrative echelons of formation headquarters, service units and installations, and appropriate echelons of the arms units. At each level of command these communications successively link the administrative echelon of the senior formation headquarters to its subordinate counterparts, thus completing an area wide administrative net radio system. Within formations, nets are organized as required to fulfil various personnel and logistic functions, eg, casualty clearing, repair and recovery, and movement and traffic control.

g. **Special Purpose Radio Nets**. In addition to the above, some nets may be established for special purposes. Examples follow:

(1) **Long Range Patrol Nets**. For communications to long range patrols operating deep in enemy territory, some special nets with special capabilities may have to be set up.

(2) **Liaison with Military or Civil Government**. Special nets or links may be established at higher formation headquarters to ensure co-ordination with military government in occupied territories, to communicate at all levels of command with a variety of civil agencies in operations in support of government, and to communicate to military and civil authorities on both sides of the buffer zone in peace-keeping operations.

DEPLOYMENT

4. Characteristics of CNR demand that stations be carefully sited. Within a headquarters area, stations may be sited with the supported functional groups or remotely located at a radio park some distance away. The latter method is advantageous in that it reduces the concentration of men and vehicles around the command post (CP) area, lessens the risk of the enemy electronically determining the position of the CP, and permits the stations to be sited to the best technical advantage. Its disadvantages include the need to defend an additional echelon area, the possible loss by enemy action of many radio stations because of the concentration of the equipment, and the need to protect lengthy remote control lines.

5. Because of the reduced efficiency of radio while on the move, and of the inability of the formation headquarters staff to operate efficiently during moves, these headquarters normally divide, deploy and move in separate main and alternate headquarters in order to provide continuity and survivability. This requires duplicate radio stations or detachments for each component of the headquarters. Each headquarters component must further be component for reconnaissance.

RADIO CONTROL

6. CNR systems require a considerable degree of technical control and detailed supervision.

7. **Technical Control**. CNR frequencies and net data are planned, prepared and issued at the highest practical level. Net data includes call signs, address groups, cipher keys, codes, etc. Signal staff procedures and staff cells are established at each level of command to deal with these matters. It is important to note that frequencies and net data authorized for use at a particular level of command are always subject to the technical control of the next higher level of command.

8. **Detailed Supervision**. The detailed supervision of working CNR nets is effected in two ways:

   a. The personnel (both the staff and the operator) of the net control station ensures the operational efficiency and the discipline of the net by regulating the traffic and the operating rules.

   b. The signal officer/warrant officer responsible for the operation of one or several nets normally sets up a radio control (radcon) to monitor the conditions of his operating nets, to plan the deployment of outstations, RRB stations or relay stations in support of the tactical manoeuvre and to provide administrative and technical support to deployed elements. The associated monitor stations provide technical support by checking the suitability of frequencies but also control the transmission security of operating nets and make appropriate signal security reports.

SECTION 3

TRUNK COMMUNICATION SYSTEMS

EMPLOYMENT

1. Trunk communication systems are hybrid, multi-mode communication systems which consist of multi-channel radio relay, troposcatter or line transmission means, voice and data switches, multiplexers and sub-multiplexers and various terminal equipments. The major components of these trunk systems have been described in Chapter 3.

2. Because of their very high capacity, their ability to provide multiple modes of communication and their great flexibility, trunk communication systems extend from service battalion and brigade HQ rearward and become at division level and above, the primary communication systems used to interconnect HQ on the battlefield. Generally the capacity of the systems increases with the level of the HQ being supported. The system may be extended to arms units forward of brigade HQ either by line or by a combination of line, CNR interface devices, and single channel radio access (SCRA) equipments linked to radio access points (RAP) located at trunk nodes. The trunk communication system interconnects with strategic communication systems and extends into the communication zone.

3. Although specific trunk systems may differ in the quantity and quality of service provided, the following facilities are usually provided to the users.

a. common and dedicated user secure telephone service;

b. common and dedicated user secure narrative traffic facilities;

c. common and dedicated user secure facsimile;

d. common and dedicated user secure data transmission facilities;

e. access to radio net through CNR interface facilities; and

f. SCRA facilities to mobile users in rovers.

FUNCTIONAL ORGANIZATION

4. **Essential Elements**. The essential elements of a trunk system are:

a. access nodes;

b. trunk nodes;

c. SCRA sub-system; and

d. technical control facilities.

5. **Access Nodes**. An access node is that essential element of a trunk system which is associated and collocated with a user headquarters. It provides the users with facilities for the receipt, handling and transmission of traffic in all its forms over the trunk system. Although the size of an access node will vary with the size of the headquarters served, it normally includes some or all of the following facilities: a message centre including an off-line crypto facility, a despatch rider section, a voice and data switch and associated multiplexing and terminal equipments, a radio relay or troposcatter section, a line laying section, various user terminal equipments (telephone, computer terminals, narrative traffic terminals, facsimile terminals, SCRA, etc) and a facility control centre (FCC).

a. **Message Centre**. This facility of an access node provides users who do not have dedicated traffic terminals with a means of receiving and transmitting narrative traffic. Signal personnel in this facility accept traffic from users, prepare it for transmission on the appropriate communication system, receive traffic from the various communication systems for delivery to users and ensure the distribution of traffic within the HQ. As communication systems become more automated and provide more user-operated extensions, this facility will decrease in importance and gradually disappear. An off-line crypto facility is normally included in the message centre for super-enciphering and deciphering traffic which require such a treatment.

b. **Despatch Rider Section**. This section, although formally part of the SDS system, is normally controlled by the message centre supervisor.

c. **Switching Facilities**. This is the major facility of the access node which enables users to send and receive traffic directly to and from other users within the HQ and in other HQ or formations. Users are connected to this facility by land line through their various communication terminals.

d. **Radio Relay Section**. This is the primary trunk transmission means linking all user access nodes to the other user access nodes through trunk nodes. As stated previously, this capability is not provided at battle group level; at formation level, the numbers of radio relay detachments will vary with the size of the HQ. Furthermore, in the rear combat zone, troposcatter may replace or complement radio relay.

e. **Line Laying Section**. This section enables the access node commander to provide a communication system within the HQ, to link the various elements of the access node to the transmission system, to link the various functional elements of the HQ when required and to provide an alternate trunk transmission means in place of radio relay when tactically required.

f. **User Terminals**. Facilities provided to commanders and staff will vary in accordance with their specific needs. The trend however is to reduce the number

of Signals-operated terminals and to increase the number of user-operated terminals; these will include automatic telephone sets with varied features such as automatic recall of busy numbers, abbreviated dialling, preset automatic dialling, transfer, conference calling, priority calling, computer terminals, facsimile terminals, narrative traffic terminals, etc.

6. **Trunk Nodes**. Trunk nodes are technical facilities sited away from user HQ and generally on high ground throughout an area of operations. Their main function is to receive traffic from originators through their associated access nodes and to transmit it to the addressee or addressees through their associated access nodes. This function can be performed directly, through a relay or through one or several other trunk nodes. Since a trunk node is not related to a particular HQ, it can be sited to satisfy fully the tactical and technical considerations. Trunk nodes are made up of an FCC, a number of radio relay terminals, a voice and data switch, a line laying section, one or more radio access points (RAP) and some administrative support facilities.

a. **Radio Relay Terminals**. These terminals provide the primary transmission means to access nodes and also the internodal links between trunk nodes.

b. **Voice and Data Switch**. This is the heart of the trunk communication system. All incoming traffic is checked for its destination and automatically routed to the appropriate access nodes serving the addressees. Although there are various techniques used for destination search, the most widely used is the flood search. When the addressee's destination access node is located, the traffic will be routed to it by the best possible route, circumventing if necessary, destroyed or damaged parts of the network.

c. **Line Laying Section**. This section allows the node commander to disperse somewhat the various elements of the trunk node by linking them through cable. The degree of dispersion is governed by the topography, the tactical situation and technical limitations.

d. **Radio Access Points (RAP)**. Although collocated with and linked to trunk nodes, RAPs are properly part of the SCRA subsystem and will be described below at paragraph 7. There may be one or more RAPs associated with a trunk node.

e. **Relay Stations**. Although not properly part of the trunk node, one or more relay stations are normally attached to a trunk node in order to enable the node commander to extend his radio relay shots to access or trunk nodes. This helps him to overcome topographical obstacles, to extend his range, to site his node away from high points, to speed up his technical manoeuvre in support of fast moving formations or to site farther away from the FEBA.

f. **Administrative Support**. A number of administrative facilities may be attached to a trunk node. These could include resupply, maintenance and mobile kitchen detachments.

7. **SCRA Sub-system**. The SCRA sub-system is a facility which combines the advantages of CNR to those of the trunk communication system for those users which are too fast moving or too far forward to rely on radio relay for connection to the trunk system. This facility is provided to specific commanders and staff officers in their rovers and to lower unit HQ which do not warrant the deployment of a full access node capability. The sub-system is made up of two basic components: mobile subscriber sets and RAPs.

a. **RAP**. A radio access point is a secure duplex radio switch which receives and transmits traffic to and from mobile users equipped with a mobile subscriber set. Because a RAP is normally connected to a trunk node, it allows passage of traffic between these mobile users (normally called mobile subscribers) and the other subscribers of the trunk communication system in the various headquarters. The number of simultaneous connections which can be handled by a RAP will vary with each system. Some systems are also engineered to allow the direct connection of RAPs between themselves thus providing a form of trunk RRB, in addition to trunk nodes.

b. **Mobile Subscriber Sets (MSS)**. MSS are those facilities placed at the disposal of the user, either in his CP or his rover. A MSS is a secure duplex radio terminal, which looks much like a normal CNR. It can be associated with various peripherals to allow the passage of other form of traffic besides voice: data, facsimile, narrative, etc.

8. **Technical Control Facilities**. Modern trunk communication systems require an extensive network of control facilities for system planning, management and deployment. These are described in paragraphs 12 to 15 below.

DEPLOYMENT

9. **General**. Trunk communication systems can be deployed in one of two configurations: the chain of command or the area configuration. Although the latter has been adopted for use in the Canadian army, both are described below.

10. **The Chain of Command Trunk System**

a. The chain of command trunk system provides a number of trunk nodes linked together by radio relay in an arterial trunk paralleling the chain of command. Trunk nodes function only as relay centres for the network and are allotted to each formation headquarters. An access node is located with each of the major components of the headquarters and provides access to the trunk node over connecting line or radio relay links.

b. Each formation headquarters has at least two trunk nodes so as to move on the battlefield, to step-up and to provide alternative facilities. Access nodes are provided in sufficient quantity to meet similar requirements for continuous

operations in a mobile environment. These trunk and access nodes are moved and sited in tactical conformity with the headquarters being served.

c. From the above, it can be deduced that chain of command trunk systems are expensive in resources and provide little flexibility of manoeuvre for either the user or the signal officer.

11. **Area Trunk System**

a. In this configuration, only access nodes are related to the chain of command; although an access node normally serves only one HQ, it may be required to serve several other closely located HQ. Access nodes are not associated with a particular trunk node but simply home in onto the closest available trunk node as decided by the system control centre.

b. Trunk nodes are dispersed throughout the area of operations served so as to give efficient service to all HQ served, to optimize the traffic load of each node, to minimize restrictions on the movement of served HQ and to provide an adequate level of survivability to the system. All trunk node connections, movements and deployments are planned and ordered centrally by the system execution and plan (SEP).

c. The layout of a conceptual area trunk system serving a Canadian division is shown at Annex B. The area trunk system now in service is the Land Tactical Area Communication Systems (LTACS) and is scheduled for replacement in the early 1990's.

d. The area configuration is more efficient and cost effective than the chain of command configuration but it requires a complex control system. It is not possible without extensive automation and computer assistance.

SYSTEM CONTROL

12. **General**. An area trunk communication system requires three levels of control organizations:

a. a facility control centre (FCC) at each node (trunk and access),

b. operational support centres (OSC) at trunk squadron and trunk regiment level, and

c. a system execution and plan (SEP) at system level (corps signal brigade).

13. **FCC**. FCCs located at each node provide direct and immediate control of all facilities subordinated to their authority. Access node FCCs are operationally responsible to the senior signal officer in the HQ which they serve but are subject to SEP technical control instructions. Trunk node FCCs are responsible to their hierarchical signal commanders (squadron

commanders) for the efficient execution of technical orders received directly from the SEP. The tasks of FCCs include:

a. installation of staff terminals as required,

b. operation of all facilities,

c. establishment and maintenance of appropriate network connections with the best circuit utilization,

d. signal security of facility operations,

e. movement and deployment of the facility within prescribed time and standard limitations,

f. close in defence of the facility,

g. technical maintenance of the facility within authorized limits, and

h. provision of status information and movement warning to the SEP and OSC.

14. **OSC**. OSCs are collocated with one of the trunk nodes under their command. They are based on trunk regiments' HQ which may form sub OSCs based on squadron HQ. Although they exercise command over a number of trunk nodes, they are excluded from real-time system planning and engineering which is done centrally by the SEP. Their role is one of operational support and include the following tasks:

a. before operations, training subordinate nodes to the required battle standard, and ensuring their operational readiness;

b. during operations, ensuring that nodes perform to the required battle standard;

c. ensuring that damaged or unserviceable nodes or node elements are repaired/replaced as soon as possible;

d. ensuring the timely refit of off-duty nodes to permit their return to duty;

e. effecting liaison with supported formation HQ signal officers;

f. effecting liaison with supporting administrative installations to ensure the efficient administrative support of their unit/subunit; and

g. advising SEP on the employment of trunk nodes according to their capability. Because of the nature of their duty, OSCs are dispersed on a geographical basis throughout the area of operations. They are subject to orders/instructions from the SEP.

15. **SEP**. The SEP is the staff agency used by the appropriate signal commander to plan, direct and control the employment of the area trunk system. The SEP exercises direct technical control over all trunk system FCCs and OSCs to which it issues orders and instructions to ensure that the trunk system fully supports the tactical communication plan. The SEP also possesses its own FCC to ensure the operational readiness of its own sophisticated equipment. The tasks of the SEP include:

a. translating the tactical manoeuvre plan into a trunk system manoeuvre plan,

b. planning trunk node and relay station movement and connections to ensure satisfactory access node connections as requested by subordinate formation/unit signal officers,

c. managing frequencies for node connections,

d. managing system signal security,

e. preparing and issuing the required signal instructions to subordinate FCCs and OSCS,

f. controlling ordered manoeuvres,

g. maintaining electronic status files for all facilities,

h. maintaining ground/high point availability files,

j. updating the digital map data,

k. coordinating the administration and operational support of deployed facilities through the OSCs, and

m. monitoring traffic state and ordering remedial action when required.

SECTION 4

SIGNALS DESPATCH SERVICE (SDS)

EMPLOYMENT

1. The principal communication system using hand carriage is the SDS. It consists of scheduled or special courier runs by Signals personnel called despatch riders between HQ or even between commanders or important staff officers along predetermined routes in order to convey specified traffic.

2. SDS is especially useful under conditions of electronic or radio silence, of heavy enemy RECS attack, or for the carriage of important but voluminous documents. Personal mail, stores, equipment, valuables, and explosives are not accepted for transmission. In addition, limits may be imposed locally, usually within an area of operations, on the maximum weight and dimension of traffic.

3. On occasion, Signals may also use SDS to clear backlogs of traffic when other communication systems are overloaded,
damaged or destroyed.

4. Motorcycles, vehicles, aircraft, boats, or trains may be employed as the mode of transport.

ORGANIZATION

5. At formation HQ, despatch riders are normally grouped under the control of the message centre supervisor. They are provided in such numbers as to permit several scheduled runs daily and the provision of unscheduled runs on an emergency basis. At unit level, the numbers provided rarely permit scheduled runs.

6. Scheduled runs are organized by Signals so as to coincide with peak traffic periods and to permit the optimal linkage of traffic between SDS services at the various levels of command. The runs follow the chain of command but are normally broken up on a geographical basis to take into account distances, going conditions and the number of stopovers. Signals at a command level are responsible for the transmission of despatches to subordinate, supported and flanking headquarters. When requested external units or formations in location can be added to despatch runs.

7. Special Despatch Riders (SDR) are normally kept in reserve to cater for unforecasted and unscheduled delivery of important traffic which cannot wait for the scheduled runs and cannot be delivered through other communication systems.

8. **Custody of Despatches**. It is a principle of SDS that traffic allocate for this form of transmission remains in the custody of Signals until delivered to the addressee. An exception is made to this rule in the case of liaison or other visiting officers who are responsible for collecting any traffic for the headquarters to which they are proceeding. Traffic handled in this manner is

restricted by the level of security classification and must be delivered to Signals at the destination.

9. **Use of Aircraft**. Air delivery methods are used when distances are excessive, terrain is impassable to wheeled vehicles, or where ground routes are hazardous. Assigned and casual flights are utilized for this purpose. Conditions that may hamper this form of delivery include poor flying weather, night flying and landing restrictions, and vulnerability to enemy anti-air weapons. Capsule dropping and pickup techniques may be used when conditions preclude aircraft landing. Although fixed wing aircraft may be used, it will be more common to use helicopters for this purpose in the forward combat zone. When aircraft are employed, the DR usually accompanies the aircraft, and receiving units are responsible for collection and delivery at the point of landing.

10. **Protection**. When the combat zone is subject to enemy infiltration, one or more of the following protection measures may be used if recourse to an air delivery system (ADS) is not possible:

a. variations in routes and times;

b. use of ground escorts and mounted guards;

c. employment of double DR teams; and

d. encryption of messages.

CONTROL

11. SDS routes and timings are planned by Signals and submitted for staff approval.

12. Only officers empowered to release traffic of immediate or higher priority can authorize SDR runs.

CHAPTER 5

ORGANIZATION OF SIGNAL FORMATIONS AND UNITS

SECTION 1

REQUIREMENT

GENERAL REQUIREMENT

1. Signal formations, units or elements are found at all levels of command. In the combat zone, some are an integral part of combat units, others are deployed in general support of combat formations. In the communication zone, some support headquarters, installations and units, others support national headquarters and installations in the allied lines of communications when abroad and in the national theatre at home.

2. Signal units are divided into two broad categories: units providing communication support and others providing EW support. These two functions are rarely combined within one unit, except at the lower levels of command. Communication units in the combat zone which are assigned to an all-arms formation HQ are also responsible for the HQ's protection and administration. In general, communication units not specifically assigned to a HQ provide their services on a geographical basis.

3. Signal units are made up of a number of common functional blocks which are selected and tailored according to the role, tasks and deployment of the units on the battlefield. These common blocks are described below.

a. **Command and Control**. An internal command and control element is required for the formation or unit. These may be signal CP, SEP, OSC, FCC, or EW coordination centres (EWCC).

b. **Transmission Facilities**

(1) CNR, including air/ground/air (A/G/A) radio,

(2) SCRA,

(3) radio relay,

(4) troposcatter radio,

(5) satellite radio,

(6) line, and

(7) SDS.

c. **Access Facilities**. Access nodes or signal centres, including:

(1) message centre,

(2) voice switch,

(3) data switch,

(4) cipher, and

(5) multiplexing and terminal equipments.

d. **Signal Security Facilities**

(1) monitoring, and

(2) distribution accounts.

e. **EW Facilities**

(1) ESM (intercept, analysis and DF), and

(2) ECM (deception and jamming).

f. **Defence Elements**. For all-arms formation HQ only.

g. **Administrative Facilities**. These contain:

(1) supply,

(2) transport,

(3) maintenance,

(4) personnel administration (adjutant, postal, padre, canteen, etc), and

(5) medical.

4. Signal units must conform to the tactical environment in which they operate; therefore, their organization and equipment is different in or out of the combat zone.

COMBAT ZONE SIGNALS

5. **Units**

a. At unit level, the command and control system is mostly made up of CNR, with some access to the trunk system either by SCRA or land line. Most communications are verbal, so there is only a need for a small signal centre which includes a switch, a small line element, an SDR capability and a skeletal message centre. Most of the communication equipment is user operated.

b. To satisfy the above need, a signal platoon or troop is integral to most units; it is headed by a signal officer and composed of signal personnel and regimental signallers. The platoon/troop operates the facilities at the unit HQ and the echelon CP, manages the unit command and control system, and provides first line telecommunication maintenance.

6. **Brigade**

a. At brigade level, the command and control system is more extensive and includes all major means: ACIS, CNR, trunk system, SDS. Nevertheless CNR is still the primary means. Provision is also made for HQ survival by the deployment of alternate facilities. In an all-arms brigade HQ the signal unit is also responsible for the protection and administration of the HQ; in single-arm brigade HQ signals do not provide protection.

b. In order to fulfill the above requirement, Signals provide a Headquarters and Signal Squadron which is made up of a HQ, an access troop, a radio troop, a defence and security (D&S) platoon (all-arms brigade only) and an administration troop. This unit is capable of operating and managing the brigade level communication facilities linking into the higher formation communication system, establishing communication with flanking formations and providing communication maintenance support within the Ordnance Engineering System (OES).

7. **Division**

a. The communication systems to be operated are the same type as for the brigade level. However the numbers of users and the distances to be covered are greater and the trunk system now becomes the primary means. This is also the first level of command with integral EW capability.

b. At this level, Signals provide a Headquarters and Signal Regiment made up of a HQ, an access squadron, a radio squadron, an EW squadron, a D&S company and an administration squadron. This unit is capable of operating and managing the division level communication systems, providing the appropriate links to higher and flanking formations, providing an integral EW capability and the appropriate

communication maintenance support within the OES. However because of the wide scope of his coordinating responsibilities with corps, divisional troops, brigades and flanking formations, the commanding officer of the HQ and Sig Regt, who is also the division signal officer, is provided with a separate signal staff to carry out the detailed division level signal planning and co-ordination.

c. Division troops have integral signal elements appropriate to their size and tasks.

8. **Corps**

a. At this level, the greater distances, the high number of users and the type of traffic call for extensive and complex communication systems. The area trunk system is the major traffic carrier and is supplemented by SDS and some CNR. An extensive EW capability is also required to support the corps and integrate the operations of EW facilities at division level. The interface with operational and administrative installations, host country and national command elements in the communication zone adds also to the complexity of the systems.

b. Signals require a complete formation to meet the demand at this level. A signal brigade is therefore provided to operate, engineer and co-ordinate the corps command and control system. This brigade is made up of the following elements:

(1) a signal brigade HQ which includes an SEP to direct the deployment of the corps area trunk system,

(2) an access regiment for main HQ and an access squadron for rear corps HQ,

(3) trunk regiments to deploy the area trunk system infrastructure for the complete corps,

(4) an EW regiment,

(5) a line construction regiment,

(6) a signal workshop squadron, and

(7) a signal security squadron.

c. Corps troops also have integral signal elements appropriate to their size and role.

COMMUNICATION ZONE SIGNALS

9. The communication zone is that part of the area of operations extending from the combat zone rear boundary to the port/beach complex which supports entry into the area of operations. The installations situated herein are described in B-GL-300-000/FP-000, Chapters 7 and 10. The specific command and control needs which may arise in the communication zone are:

a. area command and control;

b. movement control (road, air, sea, rail);

c. air traffic control;

d. air defence;

e. meteorological services;

f. rear area security;

g. military police;

h. internal communication for all operational and administrative formations or installations deployed; and

j. joint and combined operations communications.

10. To support a communication zone, a signal command is established under a chief signal officer (CSO) who is also the area CSO. The command is organized on a geographical basis and each signal formation within a sector includes functional elements tailored to the needs of the communication zone installations supported but also capable of reinforcing the signal units of the combat zone. A typical command could include:

a. A forward area command Signal Support Group, which could include, for example:

(1) an area HQ signal regiment,

(2) a personnel command signal squadron,

(3) an area support group signal squadron,

(4) line construction regiments,

(5) troposcatter/RR regiments,

(6) a signal reinforcement regiment, and

(7) a signal security regiment.

b. A rear area command Signal Support Group, which could include:

(1) a communication zone HQ signal regiment,

(2) an engineer command signal regiment,

(3) a transport command signal regiment,

(4) line construction regiments,

(5) troposcatter/satellite regiments, and

(6) a signal security regiment.

c. An EW Regiment, which would provide interface with national and allied strategic EW organizations, in depth area coverage and support to forward EW units.

ESTABLISHMENTS

11. The detailed organization and employment of combat zone signal units are described in the following publications:

a. B-GL-303-001/AF-001 Staff Manuals, Volume 1, Corps '86 Establishments;

b. B-GL-321-002/FT-001 Signals in Battle, Volume 2, Signals in the Brigade and Brigade Group;

c. B-GL-321-003/FT-001 Signals in Battle, Volume 3, Signals in the Corps and the Division; and

d. B-GL-321-004/FT-001 Signals in Battle, Volume 4, Tactical Electronic Warfare.

SECTION 2

ORGANIZATION AND MOVEMENT OF FORMATION HEADQUARTERS

GENERAL

1. A formation headquarters is a facility which exists to assist a commander to plan, direct, coordinate and control all stages of an operation. Signals have been given the responsibility for the protection, movement and administration of all-arms formation headquarters.

ORGANIZATION

2. **HQ Components**. To facilitate control and to gain protection through dispersion, a formation headquarters may be divided into a number of components. These are:

a. **Main Headquarters**. This component is concerned with the tactical aspects of command and control over subordinate formations or units. It consists of the operations division staff (G2/G3), arms advisers, and a small administration staff (G1/G4) with their supporting personnel and communications. The signal command group normally operates from main HQ. In some situations personnel and vehicles not immediately required at main headquarters may be located at an administrative echelon situated some distance away.

b. **Rear Headquarters**. Rear HQ is the component responsible for planning and controlling the administrative aspects of the formation's operations. As such,it provides detailed direction to the service formations/units located in the formation administrative area. It consists of the administrative staff (G1/G4/G5), service advisers, and allotted communications. This component is not formed at brigade level where all staff branches are collocated.

c. **Tactical Command Post (Tac CP)**. The Tac CP is a small temporary command element which is formed when the commander must go away from main headquarters to direct operations. In addition to the commander it may consist of one or more personal and general staff officers, selected arms advisers and a protection party, together with appropriate communications. It may be vehicle mounted or airborne.

d. **Alternate Headquarters**. A HQ component which ensures the continuity of control when main HQ is not in operation. It contains the necessary staff and facilities to assume control of the formation during a move of main HQ or in the event of the latter's destruction. Main and alternate HQ are never collocated.

3. **Functional Groups**

a. A typical main headquarters is composed of the following major groups:

(1) **Command Group** - consisting of the commander, the chief of staff, arms advisers, personal staff, selected general staff officers and a protection party.

(2) **Operations Centre** - consisting of the operations branch, intelligence branch, fire support co-ordination centre (FSCC), engineer, signal, aviation and administration coordination staff.

(3) **Signal Group** - consisting of the signal CP, radio facilities, access node facilities, D&S elements and HQ housekeeping facilities.

b. A typical rear headquarters is composed of the following groups:

(1) **Combat Service Support (CSS) Centre** - consisting of G1/G4/G5 staff.

(2) **Service Support Group** - consisting of service advisers for the transportation, supply, maintenance, medical, dental, mail, finance, military police, and chaplain functions.

(3) **Signal Group** - same as for main HQ.

SITING OF HEADQUARTERS

4. A headquarters is sited where it can control subordinate units and formations while communicating with higher and flanking formations.

5. The following factors must be considered in selecting a site:

a. **Communications Suitability**

(1) the surrounding topography and ground cover must facilitate communications in the desired directions,

(2) the site must be sufficiently elevated and clear to pick up incoming signals in the required strength,

(3) the proximity of operating power stations or transmission lines must be avoided,

(4) the site must facilitate the laying of local and trunk lines, and

(5) screening of electronic transmitters from the enemy's monitoring is highly desirable.

b. **Access**. It must be reasonably accessible from the formation's main axis. It must be possible to occupy or evacuate the site in any weather, by day and night. The site should be reasonably close to a landing strip or landing zone.

c. **Space**. There must be sufficient space for efficient operation and adequate dispersion.

d. **Protection**. The site must provide cover from air observation, be sufficiently removed from the FEBA, be defensible against ground attack and, if possible, gain protection from nearby combat units.

e. **Preparation**. The site should require minimum signal or engineer preparation before occupation.

LAYOUT OF SITE

6. It is impossible to propose a layout suitable for all occasions: siting a HQ in a forest or in a town offers drastically different challenges to the reconnaissance officer. Nevertheless, there are some basic groupings and relationships which should be sought:

a. **The Operations Centre (CSS Centre for Rear HQ)**. This is the hub of the HQ and should be at its geographical centre. It must be easily accessible from all other functional groups but especially from the visitor's car park, message centre and command group. It is normally guarded by a security picket and enjoys all around protection from the other elements of the HQ.

b. **The Command Group**. Although close to the operation centre, it should be sited in a quieter area away from the main entrance so as to permit reflection.

c. **The Signal Group**. For siting purpose this group is sub- divided into several elements.

(1) **Sig CP**. Should be sited close to the operations centre and to the signal operating facilities, so as to make control easier.

(2) **Access Facilities**. These, including the message centre and line distribution point should be sited close to the entrance of the HQ so as to minimize the movement of DRs in and out of the HQ.

(3) **Radio Park**. When radio transmission facilities are not in hardened staff vehicles, they are regrouped in a radio park on the periphery of the HQ. The radio park could even be sited in some cases, one or two km away from the HQ proper. Security of remote lines is a factor in deciding the radio park location.

(4) **Administrative Facilities and Rest Area**. Depending on the tactical situation, these can be sited totally in the HQ or split in an A1 echelon collocated or an A2 echelon remoted five to ten km away.

7. Annex C provides a suggested schematic layout of a main formation HQ.

RECONNAISSANCE OF SITES

8. Because they must move frequently and on short notice, lower formation headquarters, will usually have a number of alternative sites reconnoitered before the decision is made to move. This reconnaissance is done on a continuous basis so as to speed up the preparation and occupation sequence. At corps level and higher, because of the accommodation requirements and the effort involved in moving the headquarters, the frequency of moves is somewhat lower, and preparation and occupation of the site may require considerably more time.

9. The following is a general procedure for the selection and reconnaissance of a headquarters site. The sequence may be compressed and duties varied as circumstances permit. Major steps are:

a. initial proposal to move made by G3, and tentative area(s) determined and agreed from map between G3 and Signals;

b. preliminary reconnaissance by air made by headquarters reconnaissance officer (this step is not essential);

c. detailed ground reconnaissance of chosen site, conducted by reconnaissance party;

d. estimated work and time calculated - the lay out is decided;

e. suitability of site confirmed to operations which decides movement timings;

f. move carried out by echelons (advance party, main body, rear party).

MOVEMENT OF A HEADQUARTERS

10. A headquarters must change its location in order to keep its subordinate formations or units within controlling range, and to avoid detection and destruction. It is the responsibility of Signals to move the headquarters in accordance with direction issued by the staff after consultations.

11. The following factors affecting communications must be considered when planning moves of headquarters:

a. **CNR**. Although radio can be operated on the move, ranges may not be as great as when stationary. This should be taken into account when planning the move and RRBs deployed accordingly.

b. **Trunk System**. While on the move:

(1) access to the trunk system is restricted to SCRA facilities, and

(2) line may be required at traffic control points if security considerations preclude the use of radio.

c. **DRs**. DRs are normally allotted to each major echelon for the move. The few DRs available with each group must, therefore, be reserved for vital traffic.

12. A headquarters is very vulnerable to attack when changing locations. A protective element must be included in each of the major echelons and additional support may be required during the period the move is taking place.

METHODS OF TACTICAL MOVEMENT

13. A formation headquarters may move by air or road. As formation headquarters are established with a considerable number of vehicles, the usual method is by road:

a. With the exception of armoured formation headquarters, any tactical headquarters may be moved by tactical transport aircraft.

b. Because of the considerable tactical airlift needed, a move involving tactical transport aircraft is normally conducted in conjunction with a road move, unless the HQ is specifically organized for an airborne role.

14. Road moves are normally carried out by packets. A packet is a group of 5-10 vehicles from one functional group moving together. A packet is led by a packet leader who has been briefed as to destination, route to be followed, sequence and speed of movement, likelihood of attacks en route, and who is responsible for moving his packet safely from the old to the new location.

15. Formation HQ components use two methods of movement: the leap frog method and the step up method.

a. **Leap Frog Method**. Under this method, main and alternate HQ deploy separately and never meet. Main HQ deploys to location A whilst alternate HQ deploys to location B and remains passive whilst monitoring the situation. Main HQ controls operations until it decides a move is required; after ascertaining that alternate HQ is ready, main HQ transfers control of operations to alternate HQ and becomes passive in turn. The HQ command group leaves main HQ and joins alternate HQ. Meanwhile main HQ moves to location C where it monitors the situation and waits to resume control on order. This cycle can be repeated endlessly, each component assuming control in turn, to the limit of its endurance or according to the tactical situation.

b. **The Step-Up Method**. Some formation HQ may not have an alternate capability and must move one leg at a time. This is called the step-up method. When a move is required, a reconnaissance party is deployed; once a site has been found, the main HQ detaches an element called a step-up to the new site, where it sets up and gets ready to assume control on order from main HQ; when main HQ relinquishes control, it quickly joins the step-up at the new location where main HQ is re-formed.

GROUPING AND TASKS FOR MOVE

16. A headquarters is usually divided into the following major groupings for movement purposes:

a. commander;

b. reconnaissance party;

c. advance party;

d. main body; and

e. rear party.

17. Their action during movement:

a. **Commander** - under both methods the commander keeps his freedom of movement and may choose to move away from main HQ in his tactical CP, or to move to the alternate HQ or to the step-up.

b. **Reconnaissance Party** - conducts security sweep of the area; verifies suitability for communications; lays out defences, landing strips or zones, traffic circuits, and car parks; marks out the site and guides the advance party.

c. **Advance Party** - prepares the site physically for occupation including the communications for the headquarters in the new location and guides the main body.

d. **Main Body** - marshalls and moves the headquarters in a protected manner.

e. **Rear Party** - It is normal for a HQ which ceases operations and moves, to leave behind a small rear party to pick up lines, make a security sweep and redirect visitors to the new HQ location.

CHAPTER 6

PROTECTION

SECTION 1

GENERAL

INTRODUCTION

1. Protective measures are those measures a commander takes to safeguard his command against surprise and to conceal his dispositions and activities from the enemy. Protective measures are the responsibility of all commanders and are implemented as a matter of drill or routine based on immediate needs or circumstances. Standard practices are described in standing operating procedures (SOPs) and additional measures called for by the immediate tactical situation are detailed in specific orders.

2. Unit commanders are responsible for deciding the measures to be adopted according to the threat or contingencies. Signal unit COs are responsible for:

   a. the protection of isolated communications sites;

   b. in headquarters and signal units, the defence of all headquarters components and the HQ echelon; and

   c. in all other signal units, the security of all signal installations under their immediate command.

3. For signal units, protective measures may be considered under the following headings:

   a. local defence;

   b. signal security; and

   c. defensive EW.

SECTION 2

LOCAL DEFENCE

PURPOSE

1. Measures for the local defence of a headquarters or signal installation are aimed at:

    a. providing early warning of enemy action, approach, intrusion or infiltration;

    b. ensuring the survival of the headquarters or installation by:

        (1) minimizing the effects of strafing, bombing, mining, and NBCW; and

        (2) the optimum use of the available combat power to repel an actual attack.

2. Measures must be tailored to ensure the best protection whilst minimizing the disruption to the primary tasks of all personnel.

GENERAL MEASURES

3. The protection of a HQ or signal installation is ensured mainly by a number of general measures, which all contribute to the HQ's ability to survive.

4. These are:

    a. **Concealment**. Sites in forests or building complexes should be picked which allow the physical concealment of facilities and vehicles: camouflage, track, light and movement discipline aid concealment. This requirement adds pressures to keep the facility small.

    b. **Cover**. Whenever possible, facilities should be in armoured vehicles especially in the forward combat zone; when this is not the case, digging-in or siting in hardened facilities should be a primary consideration.

    c. **Dispersion**. Facilities should be dispersed so as to prevent destruction by a single strike (air or artillery).

    d. **Siting**. Whenever possible HQ or signal installation sites should be selected so as to gain some protection from proximity to other combat units.

    e. **Movement**. Even with the best measures, a HQ or signal facility can be expected to have been identified and located after a period of time which will vary according to a number of tactical and technical factors. Signal COs will therefore take measures to have the HQ or facility move periodically.

ORGANIZING THE LOCATION DEFENCE

5. The defence system is based on the following elements:

   a. a defence perimeter;

   b. a surveillance plan; and

   c. a fighting plan.

6. **Defence Perimeter**. Once the deployment area is defined, the commander decides on the defence perimeter which should:

   a. be protected by natural or man-made obstacles,

   b. not be dominated by close-by features,

   c. offer clear fields of fire.

   d. be tightened up at night.

7. **Surveillance Plan**. The following are included in surveillance plans.

   a. An anti-aircraft sentry post, also responsible for observing nuclear explosions and warning against aerial delivery of chemical agents.

   b. A network of ground observation posts/guards/patrols responsible for:

      (1) controlling access to the HQ/installation;

      (2) observing likely infiltration routes;

      (3) observing likely ground attack routes;

      (4) watching for NBCW attacks; and

      (5) sounding the alarm according to prearranged signals such as firing, shouting, radio/telephone, visual signal, etc.

8. **Fighting Plan**. This plan will include obstacles, fire and manoeuvre aspects.

   a. **Obstacles**. The defensive capability of the HQ will be enhanced by the laying of obstacles, mines, and flares on the outer perimeter.

   b. **Fire**. All HQ personnel must know:

(1) their firing position by day and by night, together with their arcs of observation and fire and the degree of preparation of their position, and

(2) their firing orders and signals.

c. **Manoeuvre**. A small number of personnel will be designated by the officer responsible for the defence to form a small manoeuvre element that he can lead during an attack either to reinforce a threatened point or to destroy infiltrated elements.

9. **Training**. A HQ or signal installation defence plan is only effective if all personnel understand what they have to do and how it fits into the overall plan, can do it instantly and exercise strict fire and movement discipline. The protection plan must be rehearsed in daylight and in darkness.

DEFENCE ON THE MOVE

10. SOPs may include some or all of the following protective measures to be employed during a move:

a. arrangements for route reconnaissance prior to movement;

b. allocation and positioning of security elements in the column;

c. counter-ambush drills and action on reaching an obstacle;

d. action in the event of an air attack;

e. convoy control, warning, and relief procedures;

f. coordinating measures when escorts or picquets are employed; and

g. rally points if the convoy has to disperse for tactical reasons.

COMPROMISE AND CAPTURE

11. Signal personnel, equipment, and documents are prime and vulnerable targets for enemy capture.

a. Signal equipment, when captured by the enemy in a usable state, presents an immediate resource for re-use or a subject for intelligence investigation.

b. Signal personnel must have certain knowledge in order to carry out their duties. In the event of capture, it is likely that they will be subjected to detailed interrogation to elicit this information.

12. SOPs must state the action to be taken to prevent the capture of documents, traffic, and usable stores and equipment. Special destruction devices may be issued for the destruction of despatches, classified documents, and equipment in such a contingency. Priorities and methods of destruction for technical equipment are described in STANAG 2113, which is repeated in part at Annex D.

13. Conduct after capture, including evasion and escape techniques, is described in B-GL-318-005/FP-001.

SECTION 3

SIGNAL SECURITY

DEFINITIONS

1. Signal security is a generic term which embodies all protection measures included in communication security and electronic security.

2. Communication security is the protection resulting from the application to telecommunications and comsec information of security measures. These measures are intended to deny unauthorized persons information of value which might be derived from the possession and study of such telecommunications or information, and to insure the authenticity of such telecommunications/information.

3. Electronic security is the protection resulting from all measures designed to deny to unauthorized persons information of value which might be derived from the interception and study of non-communication electromagnetic radiations, and to ensure the authenticity of such radiations.

SCOPE

4. Current doctrine recognizes five major components of signal security; they are:

   a. crypto security,

   b. transmission security,

   c. emission security,

   d. physical security, and

   e. personnel security.

5. **Crypto Security**. Crypto security is a component of signal security which results from the provision of technically sound crypto systems and their proper use.

   a. Crypto systems consist of associated materials which provide a single means of encryption and decryption; they may be of high grade if long term resistance to analysis is required or low grade, if short term security only is required. These systems may include:

      (1) authentication system,

      (2) voice codes,

(3) ciphony equipment,

(4) cryptographic equipment (for narrative, graphic and data communication),

(5) identification friend or foe (IFF) transponders, and

(6) embedded cryptologic into ADP equipment to protect selected data, data bases and data files.

b. Crypto security can only be maintained if crypto systems are used, handled and maintained strictly in accordance with the relevant instructions.

c. Violation or compromise of crypto security must be promptly reported so that the damage can be evaluated and remedial action taken. SOPs lay down standardized procedures for such reports.

6. **Transmission Security**

a. Transmission security is a component of signal security which ensures the application of measures designed to protect transmissions from enemy interception, traffic analysis and imitative deception.

b. Both peacetime and wartime transmissions are a source of valuable military information which can be derived by hostile intelligence agencies through interception and analysis of traffic. The basic data collected in peacetime is most valuable for planning operations in wartime.

c. Traffic analysis is the study of the external characteristics of transmissions and related materials (call signs, routing, precedence, etc) for the purpose of obtaining information concerning the enemy order of battle, operational activity, plans and the structure of the transmission systems. From traffic analysis, an enemy also gains familiarity with the organization and operation of the transmission system making it possible for him to imitate authentic transmissions convincingly.

d. Protective measures against interception include:

(1) For Radio Systems:

(a) use minimum transmitter power;

(b) use frequencies which enable the use of minimum power;

(c) avoid simultaneous transmissions on two or more frequencies;

(d) use frequencies above 30 MHz if possible;

(e) eliminate unnecessary transmissions including tuning and testing;

(f) reduce transmission time;

(g) use dummy antennas and minimum power for tuning and testing;

(h) use directional antennas;

(j) change frequencies as often as practical;

(k) change call signs/address groups with frequency changes;

(m) conceal instructions to change frequencies; and

(n) maintain strict net/circuit discipline.

(2) For Line Systems:

(a) use protected lines in preference to unprotected lines;

(b) use voice codes on unprotected lines to pass classified information;

(c) on unprotected circuits, classified as approved circuits by the authorized commander, pass classified information in clear only within the prescribed security limitations; and

(d) adequate physical and emission security measures must be enforced on approved circuits.

(3) For Distributed Computer Systems:

(a) implement and use a hardware and software security plan;

(b) apply port and terminal identification/ authentication measures;

(c) apply data/file access control measures;

(d) implement back up file security measures;

(e) implement system software security measures including the ability to track/record access by users/operators.

e. Protective measures against traffic analysis include:

(1) use radio facilities only when other means are not available;

(2) use only proper transmission procedures;

(3) use collective call signs whenever possible;

(4) use/exploit the radio net identification information system (RNIIS) in accordance with authorized instructions;

(5) make maximum use of crypto systems;

(6) prior to operations, maintain normal precedence and traffic levels, if possible;

(7) restrict the amount of plain language transmission to the minimum; and

(8) avoid linkage of new call signs with old call signs.

f. Protection measures against imitative deception include:

(1) enforcing strict transmission procedure discipline;

(2) thorough training in operating procedures;

(3) alertness of operators to recognize procedure irregularities and foreign transmission characteristics;

(4) direction finding of dubious transmission sources;

(5) minimum use of plain language and procedural transmissions; and

(6) correct use of authentication systems.

7. **Emission Security**. Emission security is a component of signal security which ensures the application, of measures designed to protect all emissions from interception, direction finding and electronic analysis. It is also called Tempest. These measures could include:

a. the enforcement of design emission curtailing criteria for electronic equipments; and

b. the enforcement of siting criteria for electronic equipment.

8. **Physical Security**. Physical security is a component of signal security which ensures the application of physical measures designed to safeguard classified material from access or observation by unauthorized personnel. Physical security measures ensure protection of signal security material and information against loss, theft, capture, salvage, espionage, unauthorized observation, photography or disclosure. Physical security must be maintained throughout the life

cycle of classified material, from time of production to that of destruction. These measures could include:

a. security arrangements in areas where crypto operation are performed or where crypto systems are operated or maintained;

b. accounting and safeguarding procedures for all sigsec material and information;

c. enforcement of strict transportation regulations and standards;

d. enforcement of strict procedures for the routine destruction of sigsec material; and

e. preparation of practical plans for the emergency destruction of sigsec material.

9. **Personnel Security**. Personnel security is a component of signal security which ensures the application of measures designed to ensure that personnel requiring access to classified information are properly screened, cleared and educated and that classified information is released only on a "need-to-know" basis. When an individual is deemed no longer suitable to handle classified material, he shall be removed from duty and barred from access to classified information.

APPLICATION

10. The application of signal security measures is everybody's responsibility. Indeed the collective signal security standard of an organization depends on the conscientious application of all measures by all personnel. However certain categories of appointments/individuals bear specific responsibilities:

11. **Users**. Users must:

a. assign the proper security classification to their messages before they are handed over to Signals for transmission;

b. operate transmission media (radio, telephone or computers) placed at their disposal in accordance with proper signal security regulations;

c. safeguard, handle and destroy comsec material in their possession in accordance with proper signal security regulations; and

d. report any breach or violation of security in accordance with established procedures.

12. **Signal Personnel**. Signal personnel must:

a. comply with all signal security regulations;

b. contribute to the training of all arms personnel in signal security matters;

c. advise commanders and staff on signal security aspects of tactical operations;

d. enforce signal security policies set by the commander;

e. monitor and control the execution of signal security policies and regulations;

f. report violations of signal security to the staff.

13. **Custodians**. Custodians are responsible for the proper custody, accounting, handling, safeguarding and destruction of sigsec material received from an issuing authority and required to be held on charge.

14. **Commanders**. Commanders are responsible for the maintenance of signal security within their command in accordance with regulations and other directives from higher echelon. This includes:

a. enforcing personnel security measures;

b. training all personnel in security procedures;

c. ensuring operational plans and procedures conform to signal security principles and regulations;

d. issuing proper signal security directives to all personnel;

e. maintaining a signal security control system which will ensure:

(1) proper operation of crypto systems;

(2) prompt reporting and investigation of violations;

(3) assessment of violations and the taking of remedial action; and

(4) systematic sigsec inspections within their command.

f. the appointment of a signal security officer.

15. **Signal Security Directives**

a. Signal security channels normally issue regulations and orders which are universal or have wide applications. However commanders may issue specific directives which deal with a specific operation or a specific area or apply to a specific formation or unit or a specific system. These directives must remain within the framework of overall policies and be derived from them.

b. Commanders may issue an emission control policy to state which electromagnetic and sonic emissions may be allowed within their command in order to obtain the maximum tactical advantage in a particular situation. This policy is normally translated by the staff into emission control instructions which may authorize, restrict or prohibit the operation of equipment by type, or unit or both. Emission control instructions in the land forces are an integral part of the security plan and take the form of electronic silence or radio silence instructions.

c. **Electronic Silence**. Within the commander's emission policy, electronic silence may be imposed. However on the high intensity battle field, because of the proliferation of all kinds of electromagnetic emitters and their essential role in the conduct of the battle, it will be rarely possible to impose electronic silence at large.

(1) **Factors**. The following should be considered before a decision is made:

(a) advantages to be gained,

(b) loss of facilities and difficulties incurred,

(c) possibility of achieving security goals and deception using other methods, and

(d) safeguarding of intentions and plans.

(2) **Equipment**. The following major equipment may be affected:

(a) radio transmitters,

(b) radars,

(c) surveillance, night observation devices, and navigation systems eg, active infrared (IR) equipment,

(d) active missile and ammunition guidance systems,

(e) ECM systems,

(f) lasers, and

(g) distributed data systems.

(3) **Exempted Equipment**. The order for imposing electronic silence must specify clearly which emitting electronic systems are exempted from electronic silence. This must be clearly related to the security objectives

and the retention of a minimum command and control system effectiveness. For example, surveillance radars may have to be exempted to ensure continued air defence coverage of a formation but they may be obliged to operate intermittently to prevent direction finding (DF).

(4) **Imposing/Breaking/Lifting**. Only the commander or his COS may impose or lift electronic silence. Orders for imposing electronic silence are not transmitted electronically and include the following information:

(a) systems, stations, or geographical areas affected or exempted;

(b) timings;

(c) rules for breaking and by whom; and

(d) codewords for breaking and lifting electronic silence.

d. **Radio Silence**. Radio silence may be imposed by any commander at any level. Normally used to provide security of information, it involves all radio and radio relay equipment.

(1) **Equipment**. Radio silence covers all CNR nets in all radio bands and radio relay unless exempted.

(2) **Exempted Equipment**. Receivers remain on listening watch and rear link stations remain the responsibility of the appropriate level commander.

(3) **Imposing / Breaking / Lifting**. Commanders at any level have the authority to regulate their own nets and those of their subordinates. Orders include the same information as for electronic silence except that nicknames are employed instead of codewords.

e. **Discipline**. Silence violations must be regarded as most serious breaches of discipline and must be treated accordingly. It is imperative that everyone in the area of influence be advised of plans for radio or electronic silence; this applies especially to irregular CNR users such as drivers, liaison officers (LOs) and visitors.

SECTION 4

DEFENSIVE EW

NATURE OF RECS

1. RECS is a major combat support system of the Warsaw Pact (WP) forces. It aims to limit, delay or nullify friendly forces use of command and control systems while protecting the ability of WP forces to use their own command and control systems. The major difference between RECS doctrine and our own EW doctrine is that RECS focuses more clearly on the complete integration of electronic and physical means of attack against our command and control systems.

2. RECS embraces the following activities:

   a. tactical signal intelligence acquisition through electronic search, interception, analysis and direction finding of our electronic emissions;

   b. electronic attack of our command and control system through:

      (1) jamming, and

      (2) deception (both imitative and manipulative).

   c. physical attack of identified and located elements of our command and control system through close integration of electronic and physical means of attack; and

   d. ECCM protection of their own command and control system.

PROTECTIVE MEASURES AGAINST RECS

3. **Defence Against Electronic Search, Interception, Analysis and Direction Finding**. The only absolute defence against these measures is the imposition of electronic silence. This is obviously possible only for short periods. Therefore our own command and control system must be used within the bounds of the principles of signal security and in accordance with the additional emission control instructions issued by tactical commanders. This has been explained in great detail in section 3 above.

4. **Defence Against Jamming**. Protective measures against jamming are broken down into two categories.

   a. **Technical Measures**. These are measures which equipment designers incorporate into equipment before fielding it. Examples are:

      (1) variable power setting to escape detection and/or overcome jammer power once caught;

(2) use of spread spectrum techniques;

(3) use of steerable null antennas.

b. **Operating Measures**. These are measures which system operators/users must take in the field to avoid and overcome jamming. These include many of the transmission security measures explained at para 6.d in section 3 above. Additionally each type of equipment will call for measures specific to its mode of transmission and operation. For this reason, operator anti-jamming drills must be specified in unit SOP's.

5. **Defence Against Deception**. Defence against deception demands good crypto security (on-line crypto systems and authentication systems), good transmission security and excellent circuit discipline. Operators and users which obey signal security instructions and have no operating idiosyncrasies are harder to imitate and make it harder for enemy operators to intrude in our nets.

6. **Defence Against Physical Attack**. This defence depends on a good standard of local defence; the doctrine for local defence has been explained in section 2 of this chapter.

DEFENSIVE EW

7. The tactical doctrine which embodies all the principles of signal security and the protective measures which must be taken against RECS is called Defensive EW. It is described in detail in B-GL-321-004/FT-001, Chapter 2.

CHAPTER 7

COMMAND AND CONTROL OF SIGNALS

SECTION 1

RESPONSIBILITIES

GENERAL

1. To work efficiently, the tactical signal systems must be co-ordinated as one entity; therefore, a control system must be established at all levels of command.

2. Control aims at the best utilization of all systems in order to meet operational requirements. A considerable degree of centralized planning and overall control is necessary to eliminate undesirable duplication or, alternatively, to exploit available systems to their full potential. However, substantial delegation of authority is required in the execution of the signal plan.

3. Controlling agencies are fielded as part of signal units; they exist to assist key signal officers in discharging their responsibilities towards commanders and staffs. Control and coordination of tactical systems is exercised from the highest to the lowest levels of command; thus, at any level, a signal officer is operationally responsible to his commander and subject to technical control instructions issued by the senior signal officer at the next higher level of command.

RESPONSIBILITIES

4. Responsibilities and authority of key signal appointments at every level of command on the battlefield are described hereafter.

5. **Chief Signal Officer (CSO)**. Within an area of operations, a CSO is nominated to ensure the co-ordination of communications with the host country, other services, the home theatre, and combat zone; and to provide communication support within the communications zone. Within an area of operations with a predominant army component, this role would be played by the Army Group Signal officer, normally a Major General. He could be assisted by a subordinate to handle directly all the communications zone requirements.

6. **Commander Corps Signals (CC Sigs)**. CC Sigs has two roles.

   a. As Commander Corps Signal Brigade, he exercises direct command of all elements assigned to the signal brigade.

   b. As Commander Corps Signals, he advises the corps commander and exercises technical control in the name of the corps commander over all signal resources in

the corps; he is authorized to issue technical control instructions to subordinate divisional signal commanders and to corps troop signal officers.

c. The details of his tasks are given in paragraph 7 on page 3-1-2, B-GL-321-003/FT-001.

7. **Commander Divisional Signals (CD Sigs)**. CD Sigs has two roles.

a. As CO of the Divisional Headquarters and Signal Regiment, he exercises direct command of all elements assigned to the regiment.

b. As Commander Divisional Signals, he advises the division commander and exercises technical control in the name of the division commander, over all signal resources of the division; he is authorized to issue technical control instructions to subordinate brigade signal officers and to divisional troop signal officers.

8. **Brigade Signal Officer**. The Brigade Signal Officer has two roles.

a. As CO of the Brigade HQ and Signal Squadron, he exercises direct command of all elements assigned to the squadron.

b. As the formation signal officer, he advises the brigade commander and exercises technical control in the name of the brigade commander, over all signal resources of the brigade; he is authorized to issue technical control instructions to all unit signal officers.

c. The details of his tasks are given in paragraph 10, page 3-1-3/3-1-4, B-GL-321-002/FT-001.

9. **Unit Signal Officer**. The signal officer commands the unit signal troop/platoon (where there is one) and acts as signal advisor to the CO and staff. He is responsible to the CO for the operational effectiveness of the unit command and control system. This includes individual and collective signal training, operation of the unit communications and first line maintenance of the system's equipment. In addition, he may act as a duty operations officer in the unit CP and be a member of the reconnaissance party.

CO-ORDINATION

10. Many aspects of signal activities require co-ordination.

11. **Frequency Spectrum**. Strict controls on the use of frequencies are needed to avoid interference and make the best use of available bands. This involves:

a. allotment and assignment of frequencies;

b. co-ordination of the employment of all frequency emitters;

c. supervision of the use of all frequencies; and

d. investigation of interference reports.

12. **Signal Security**. Signals at all levels are responsible for:

a. advice and assistance to staff on measures to ensure signal security;

b. provision of signal security material and crypto facilities; and

c. enforcement of the commander's signal security policy by monitoring all systems and reporting breaches of security to the appropriate commander.

13. **Provision of Signal Resources**. Men and equipment are provided as follows.

a. **Establishments**. Unit establishments indicate clearly the level of signal personnel and equipment to be provided for all units at all levels of command. These provide the basis for provisioning and replacement scales.

b. **Replacements**. Because of the variety of signal trades and the relatively few such personnel in the replacement stream, Signals advises on the allocation of signal replacements.

c. **Supply of Signal Equipment**. Signals coordinates the issue of all replacement signal equipment within the area of operations on behalf of the operations staff.

d. **Maintenance**. Signals advises the staff on the assignment of maintenance priorities. Signals role in the electrical and mechanical engineering system is explained elsewhere.

14. **Signal Planning**. Communications and EW plans must be compatible with the operational plans of the supported staff at the next higher and lower levels of command. Therefore, it is vital that plans be co-ordinated, if not conceived, in conjunction with the affected headquarters or agencies.

15. **Technical Control**. To ensure the coordination of signal plans, a system of technical control agencies is established. These agencies are constituted at each level of command and at each critical point of the communication systems; they interrelate according to a strict hierarchy as described in Figure 7-1 and explained hereafter:

a. **Signal Command Post (Sig CP)**. The common technical control agency at all levels of command is the sig CP. Its basic function is to plan, direct, control and co-ordinate the operation and deployment of assigned signal systems. There are sig CPs at signal brigade, regiment, squadron and troop level. Depending on the

complexity of its task each sig CP may include one or more of the following discrete sub-elements:

(1) **System Execution and Plan (SEP)**. This facility exists only at HQ corps signal brigade to control the deployment of the entire corps area trunk system. Tasks of the SEP are at Chapter 4, section 3, paragraph 15 of this manual.

(2) **Operational Support Centre (OSC)**. This facility exists at trunk regiment level to ensure the support of trunk nodes. Trunk node squadrons may constitute sub-OSC if required. Tasks of the OSC are at Chapter 4, section 3, paragraph 14 of this manual.

(3) **Facility Control Centre (FCC)**. This facility is the most commonly found technical control agency as it applies to all signal systems at all levels of command. For CNR, the FCC is called a radio control (RADCON); for area trunk system nodes, it is a system control (SYSCON). This facility permits the detailed supervision of a signal system or sub-system (CNR, line fault control Centre, access node, trunk node, SCRA RAP, SEP facility itself, EW).

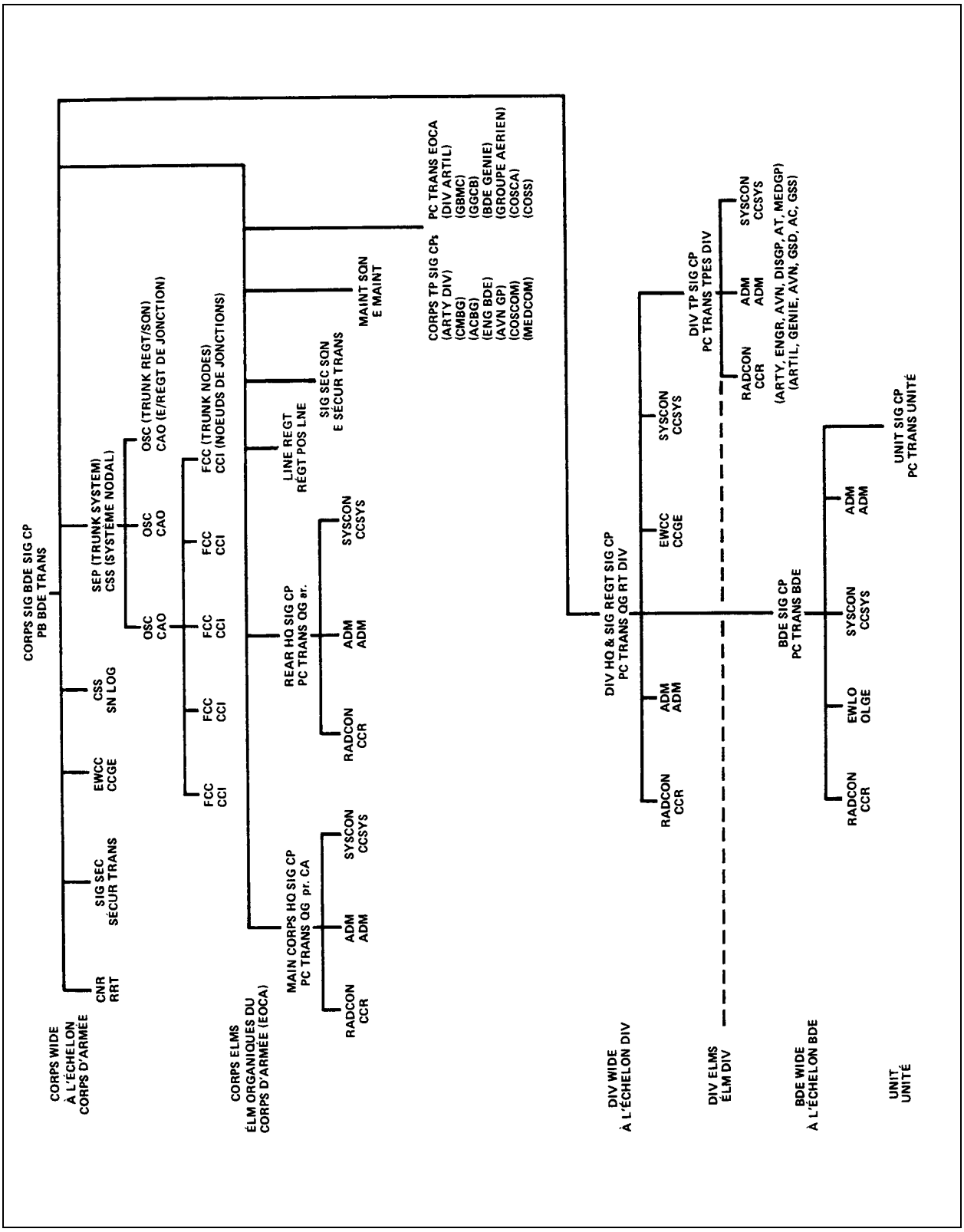

Figure 7-1 Hierarchy of Signal Control Agencies

b. **Corps Sig CP**. This is in fact the staff of the signal brigade HQ which is located close to corps main HQ with an alternate element at corps alternate headquarters. It must not be confused with the Main Headquarters and Sig Regt sig CP. CFP 321(3) explains its duty in detail.

c. **Div Sig CP**. This is an element of the divisional headquarters and Sig Regt deployed at division main headquarters. In addition to the technical control agencies depicted in Figure 7-1, it is established with a small signal planning staff collocated with the general staff for close planning of future operations.

d. **Bde Sig CP**. This is the unit headquarters element of the HQ and Sig Sqn. It is normally manned by Sqn HQ personnel augmented by troop personnel as required to man the sub-elements.

SECTION 2

SIGNAL PLANNING

GENERAL

1. Signal planning is the process of determining the most economical and effective method of employing signal resources to support the commander's operational plan. Signal planning must proceed in concert with tactical planning. It is a continuous process by which signal planners prepare for future contingencies whilst controlling the course of current activities.

2. Successful signal planning depends to a large degree on the receipt of accurate, timely and up-to-date information. In particular it requires:

a. early knowledge of the commander's intentions and plans;

b. a knowledge of the superior signal officer's intention and plans;

c. knowledge of the plans of subordinate, supporting, and co-operating commanders;

d. a knowledge of the tactical situation including the enemy's RECS capabilities and activities; and

e. a knowledge of the potential of the men and material resources available to meet the communications requirements.

THE MISSION

3. The mission of the force is the overriding concern in the development of the plan. When making a signal estimate, factors are analyzed in constant reference to the aim. It is therefore essential that the mission be absolutely clear and well defined before initiating the analysis of the major factors which will eventually lead to the formulation of options and a signal plan.

FACTORS

4. Major factors in the planning of tactical signal systems are:

a. environment (including use of local facilities and the electronic environment);

b. enemy capability to interfere with own signal plan;

c. capability of own forces (including logistics); and

d. time and space.

THE ENVIRONMENT

5. The size, physical characteristics and climate of the area in which the force deploys have a strong influence on the means of communications to be used. Arctic or tropical climates may cause difficulties for signal equipment. Special problems can be expected in urban, jungle, desert, mountain and forest regions. The protection, movement, installation, operation and maintenance of signal facilities in such environments may be particularly difficult.

6. The large number of radio frequency emitters requiring a line-of- sight path places a premium on the use of high ground. Planning must ensure that emitters do not interfere with other nearby signal installations either by electronic interference or by prematurely disclosing the position. Control in the selection and occupation of sites may be necessary in areas where few suitable features exist. Coordination with the G3 staff is mandatory to ensure the proper use of high ground and to eliminate possible conflicts.

7. Both friendly and enemy forces make extensive use of the electromagnetic spectrum on the battlefield. This congestion demands a high level of skill and care in the management and employment of frequencies. Normally the frequency assignment specifies restrictions of time, power, type of emission, antenna design, and place. Specific problems which planning must resolve at all levels are as follows.

a. Type and proximity of radios to be operated within a single building, vehicle, or tactical area. Radios of supporting and co-operating formations or units must be considered as much as organic sets.

b. Redeployments and changes in groupings will increase the probability of mutual interference between nets. In operations where one formation or unit is passed through another, special provisions must usually be made to close down a proportion of the radios during the period when interference is likely.

c. In consultation with EW, G2 and G3 staff, signals must establish the GUARDED, PROTECTED and TABOO frequency lists.

8. Civilian facilities should be considered for use when available. Major advantages to be gained by the use of such systems are the speed gained in establishing communications and the likely greater range and capacity which may be available. Disadvantages are:

a. the difficulty in meeting operational requirements with a system not under direct military control. This includes:

(1) lack of supervision over traffic handling and routing, and

(2) questionable reliability of personnel;

b. the vulnerability of some civilian systems to damage by enemy covert or overt action; and

c. the difficulty of restoring a damaged system which is not known well by signals without the co-operation of civilian staff and access to plant records.

ENEMY CAPABILITY

9. Communications are vulnerable to interruption or interception from a range of hostile activities. Defensive or protective measures will vary with the threat, and signal planners must be aware of enemy capabilities when producing the plan. A knowledge of enemy resources and tactics is essential to foresee possible contingencies.

10. Depending on the threat, the following aspects must be examined in formulating the plan:

a. routing of communications around or over areas in which physical security cannot be assured;

b. special arrangements for the defence of isolated installations or protection of transient individuals or groups in areas where clandestine or penetration forces are active;

c. protective measures against strafing, shelling, or aerial bombardment;

d. ECCM in case of RECS attack;

e. deception programmes and alternative means of communication when either electronic or radio silence is imposed;

f. protection of information and action in the event of compromise; and

g. measures to reduce the risk of disclosure to enemy reconnaissance, search, and interception.

11. Local defence of headquarters and signal installations, and signal security are described in Chapter 6.

CAPABILITY OF OWN FORCES

12. If the signal plan is to be sound it must be based on a thorough understanding of the capabilities of our own forces to accomplish the mission. The analysis of our own capabilities must extend not only to the signal order of battle but to all other formations and units in the command. The analysis must take into consideration both human and materiel aspects.

13. The success of the signal plan will depend on the availability of logistics support. Considerations that may affect the signal plan a re:

a. restrictions on the numbers of personnel or equipment that may be moved into or within an area of operations because of limited transport or poor communication routes;

b. effect of delays in the re-supply schedule because of weather, enemy action, or traffic congestion; and

c. supply and maintenance of signal stores and equipment under difficult conditions, for example, the supply of serviceable batteries in the arctic.

TIME AND SPACE

14. Tactical operations are usually conducted in a number of distinct steps, each one furnishing an orderly and sequential build-up for the next. Signal plans must develop in step with the progress of tactical operations and probably slightly ahead of them. Timings are often critical, since the time available between phases may be extremely short or phases may overlap. This may affect the choice of communication systems for each phase and the predeployment of resources. Frequently, because of movement or regrouping of operational forces the use of communications facilities belonging to another unit will be required. In such cases, liaison and co-ordination will have to be carried out expeditiously.

15. Depending on the dispersion of the force and the expected speed of action, a large number of signal elements may have to be deployed quickly over relatively great distances. This presents problems of site planning, route clearance and interoperability. Priority of vehicle movement and access to suitable communication sites must be coordinated with the staff.

SIGNAL ESTIMATE

16. The process of signal planning starts with a signal estimate and plan which in turn forms the basis for the use of relevant orders and instructions. The nature of these is described in section 3. The estimate of the situation - formally called the appreciation of the situation - is a logical process of reasoning by which a commander considers all the circumstances affecting the military situation and decides on the course of action to be taken in order to accomplish his mission.

17. A signal estimate is usually composed of four elements:

a. **Aim**. That which must be achieved.

b. **Factors**. Circumstances and conditions affecting the achievement of the aim.

c. **Courses**. Methods of achieving the aim.

d. **Plan**. The best method chosen is developed into an outline plan. This plan is then promulgated in a Communication-Electronics (C-E) Annex to an operations order

(OpO) or in a C-E OpO, supported by Communications-Electronic Operating Instructions (CEO's) as required.

18. The method for drafting a signal estimate is described at Annex E.

KEYS TO SUCCESSFUL PLANNING

19. The ability of signal officers to plan successfully the signal support of operations depends to a great extent on:

a. the receipt of the accurate, complete, up-to-date and early information needed;

b. the ability to think through the signal problem in a logical but expeditious fashion;

c. a thorough knowledge of signal personnel and system capabilities including those of co-operating forces;

d. a thorough understanding of tactical concepts and plans;

e. streamlined battle procedure to speed up the planning process and to enhance the ability to react to unforeseen events;

f. good communication capability to be able to impart one's intention quickly and accurately whilst gaining the co-operation of subordinates and allies.

20. **Liaison and Visits**. Visits are essential to confirm the adequacy of communications services, to assess the situation and to obtain advance information. A signal officer makes frequent visits to the various staff centres to gain early warning of impending moves or operations. He visits subordinate signal officers periodically. He inspects his deployed detachments to ensure that systems are functioning properly and to detect budding problems.

SECTION 3

COMMUNICATIONS - ELECTRONICS ORDERS AND INSTRUCTIONS

GENERAL

1. To promulgate the direction required to execute signal plans, a system of orders and instructions is used. These may be issued through either staff or signal channels, according to their nature. In general, signal matters which are part of the commander's plan or which touch on the authority or resources of subordinate commanders are covered by orders issued by the commander or in his name by the formation signal officer. Detailed technical instructions necessary to provide signal support to further the commander's plan are issued directly by signals.

COMMUNICATIONS-ELECTRONICS ANNEXES

2. Orders detailing the tasks and grouping of several signal elements and giving the essential co-ordination details required to ensure the execution of the signal plan in support of an operation are issued by formation commanders or in their name by formation signal officers. Depending on the formation SOPs or the complexity of the tasks, formation signal officers will normally choose to issue simple orders in the appropriate paragraph of the OpO; complex orders will be issued as an EW annex and a C-E annex to the OpO. These annexes may be issued simultaneously with or separately from the main body of the OpO when signal deployment timings preclude co-ordination of the issue. In all cases, the main body of the OpO makes reference to the annexes.

3. Formats for the signal sub paragraphs of the OpO, for the EW Annex and the C-E Annex to the OpO are found at Annex F, appendixes 1, 2 and 3.

COMMUNICATIONS-ELECTRONICS OPERATION ORDER (C-E OpO)

4. The C-E OpO is normally issued by the commander or CO of a signal formation or unit to those elements under his command. Thus a C-E OpO could be issued by the commander corps signal brigade to the units of the signal brigade, by the CO of a Div HQ and Sig Regt to his squadron commanders, by the CO of a Bde HQ and Sig Sqn to his troop commanders. Exceptionally, a C-E OpO may be issued by a formation signal officer to other elements not under his command when detailing tasks for a duly authorized signal exercise.

5. The C-E OpO follows the normal format for an OpO as can be seen at Annex F.

COMMUNICATIONS-ELECTRONICS OPERATING INSTRUCTIONS (CEOIs)

6. CEOIs are issued by formation and unit signal officers at all levels of command to coordinate the operation of signal systems and subsystems. If C-E OpOs and C-E Annexes to OpOs are concerned with the "who" and "what", CEOIs deal with the "how" of signal systems operations. They contain the essential details needed for the operation and integration of signal systems. They are issued along signal channels and are intended for system operators and

supervisors.

7. The format of CEOIs is given at Annex G.

COMMUNICATIONS-ELECTRONICS STANDING INSTRUCTIONS (CESI)

8. A formation signal officer may issue standing instructions on a variety of technical subjects. These instructions are semi-permanent and normally deal with technical matters of interest to signals only. They are not connected directly with current or planned operations but are intended to facilitate signal system operation, co-ordination or maintenance.

9. Subjects suitable for such instructions are:

a. method of dealing with a defect, in widely used equipment;

b. details of enemy signal equipment which may have to be used;

c. the use of local civilian communications;

d. system and circuit numbering;

e. method of operating signal systems which cross unit/formation boundaries;

f. distribution and holding of CEOIs; and

g. distribution and holding of signal security material.

STANDING OPERATING PROCEDURES (SOP)

10. SOPs deal with a broad range of tactical, signal and administrative activities intended to become routine. These drills form the basis of all recurring activities and promote efficiency by eliminating or reducing the need to detail these steps in every plan. For signal units they may cover signal command and control measures, activities affecting staff and other users as well as those pertaining to the administration, protection and movement of headquarters.

CHAPTER 8

FREQUENCY PLANNING AND CONTROL

SECTION 1

INTRODUCTION

GENERAL

1. The general conditions for the use of the radio frequency spectrum are described in Chapter 3 and the general control functions are listed in Chapter 7. This chapter outlines the organization and method employed to plan and control the use of the spectrum for signal purposes.

2. Radio frequency management is a complex problem involving detailed planning and control which must encompass all users, military and civilian. It includes the functions of frequency allocation, allotment, and assignment.

a. **Frequency Allocation**. This is the planning process by which radio frequency bands or specific frequencies are designated for use in performing specific functions. Allocations are made for fixed, mobile, aeronautical, amateur, radar, radio location, radio navigation usage and other signal services.

b. **Allotment**. This is the designation of a number of frequencies, nationally or regionally, with restrictions, for use on either a permanent or a temporary basis.

c. **Assignment**. This is the process of designating a specific radio frequency for use at a particular station under specified operating conditions. This frequency assignment, subject to command decisions, constitutes the authority to operate the signal system.

THE FREQUENCY PROBLEM

3. Although the electromagnetic spectrum extends from DC + one Hertz to light frequencies, the internationally regulated portion of the spectrum extends from 9 kHz to 275 GHz. Nevertheless, the signal officer is responsible for co-ordination of laser device frequencies and of devices radiating noise below 9 kHz. The upper portion of the spectrum is not yet widely used due to limitations imposed by current technology and equipment. Although new transmission techniques are extending into this upper portion, progress in utilization is still falling short of the demand for space on the frequency spectrum, placed by communication systems of all types. As a result, competition for frequencies, especially for the long range services, is intense and only international control permits operation within tolerable interference levels.

4. Military forces in overseas areas may operate as guests of the host country which usually retains control of radio frequencies. Unless these forces have the status of occupation forces, all military frequency requirements must be coordinated with the host national authority.

5. As the distance between various receivers and emitters decreases, the probability of interference increases. This interference can take the form of deliberate interference or jamming by the enemy, or of unintentional interference by adjacent radios either friendly or enemy. It can be safely assumed that the enemy frequency requirements will approximate ours, thereby greatly increasing the probability of interference. Interference may occur in a deliberate or accidental manner but it has the effect of diminishing the number of clear and usable channels and these must be controlled with great skill.

SECTION 2

CONTROL

INTERNATIONAL

1. The international radio frequency regulating and coordinating group is the International Telecommunication Union (ITU),a specialized agency of the United Nations. This group is required to implement the terms of the various treaties detailing utilization of the spectrum, standardization of practice and procedure, and measures to reduce mutual interference. The ITU Radio Regulations form the basic authority for world-wide frequency allocation.

2. The International Frequency Registration Board (IFRB) is a working group of the ITU. Its primary function is to maintain a record of frequency assignments in the Master International Frequency Register (MIFR). Emission frequencies that will or are likely to cause interference beyond national boundaries according to agreed transmitter power, emission, and other criteria must be registered with the IFRB. This regulating body aims at ensuring international protection of frequency assignments in peace time.

CANADA

3. In Canada, the Department of Communications, as the national authority, is responsible for implementing international agreements covering frequency allocation and use, including registration, and for regulating those aspects of frequency control which are within national responsibilities.

4. Military frequency management in Canada and for elements of the Canadian Forces operating outside the country, is the overall responsibility of the Director of Frequency Spectrum Management (DFSM) at NDHQ. However when units outside Canada operate under NATO control, the NATO command concerned manages the frequency requirement. In the case of frequencies required for training or civil emergency, Canadian Forces Communication Command (CFCC) is the delegated authority.

AREA OF OPERATIONS

5. **General**. This article describes a typical organization for frequency planning and control within a non-NATO area of operations. The organization and methods employed in a NATO area of operations are contained in the current Allied Radio Frequency Agency (ARFA), Allied Handbook (AH).

6. **Responsibility**. The area commander exercises centralized control of all radiating electronic devices operated by forces under his command. The authority to determine policies governing the use of the spectrum by a force is normally delegated to the Chief Signal Officer (British and Canadian usage)/Director Communications Electronics (US usage).

7. **Joint Signal Board/Area Communications - Electronics Board**. This board is normally established to co-ordinate all communications - electronics (C-E) aspects including frequency control within the area of operations and between adjacent allied forces. Generally this board includes representatives of each national service and major command operating within the area and is headed by the Chief Signal Officer.

8. **Frequency Allocation and Assignment Committee**. This committee is established by the Joint Signal Board and is the working agency for the area commander in frequency matters. The main function of the committee is the development and implementation of the area frequency plan. The committee must coordinate area frequency planning with the control agencies of adjacent allied military areas and, when necessary, with national authorities. Close liaison is maintained with area operations staff to ensure that frequency planning supports current operations and long range area objectives. Other committee functions include the maintenance of frequency records and liaison with any EW organizations. Under some circumstances, host country representatives may be included in this committee. Essential records maintained by the committee are:

a. frequency allocation within the area;

b. frequency assignments within the area;

c. assignments in other areas which may affect operations; and

d. frequencies reserved by civil authority and not available for area use.

9. **Major Formation Headquarters**. At major subordinate formation headquarters, army group or corps, a signal officer is responsible for frequency co-ordination and assignment within the formation, or battlefield frequency spectrum management (BFSM). His major duties include:

a. assigning blocks of frequencies to subordinate formations and units;

b. establishing control procedures to ensure that all radio emissions are limited to authorized frequencies and operational characteristics;

c. maintaining a master list of radio frequency assignments;

d. resolving interference problems which cannot be solved at lower levels and reporting those cases beyond his power to resolve;

e. maintaining liaison with flanking and supporting forces; and

f. disseminating frequency lists to subordinate formations and units.

10. **Subordinate Levels**. At divisional level and below, signal officers are simply distributing sub-blocks of frequencies (including some spares) from the block received from higher formations to subordinate formations and units and controlling the use made of these frequencies

to ensure it respects imposed parameters. Sub-block usage must be reported to the next higher level of command.

SECTION 3

METHODS OF CONTROL

GENERAL

1. The tremendous demand for frequencies has necessitated frequency sharing by all conceivable methods. For operational use, however, only two methods are practicable:

a. **Time Sharing**. Under this method frequencies are assigned for specific periods of time. As tactical commanders require continuous communications which cannot be predictably interrupted for frequency changes, this method is reserved for appropriate non-tactical circuits operating from and within the area of operations.

b. **Geographical Sharing**. Using this method, frequencies are repeated within units or formations according to the priority of the circuit, power outputs, number and characteristics of radios employed, and their deployment on the ground.

FREQUENCY ASSIGNMENT

2. For the purposes of assignment, frequency requirements are considered in seven major categories:

a. VHF (FM) Voice;

b. HF SSB, Voice, CW and radio teletype;

c. radio relay systems;

d. tactical air-ground co-ordination, air-air nets, air traffic control, and navigation aids;

e. target acquisition, surveillance, and special weapon systems;

f. satellites; and

g. spread spectrum systems of each previous category.

3. Most radio systems require a primary and an alternate frequency assignment for reliable communications. Further,guard nets if established also require additional frequencies. All assignments must be supported by reserve lists to cover interference and formation reassignment. Frequency assignment must take into account the separation required by tactical groupings, collocated, or multiple installations. For communication purposes, two systems of geographic sharing of frequencies are employed for net radio, and, depending on the size of the system, a choice of either of two methods is available for radio relay systems.

REGIONAL SYSTEM

4. In the regional system of frequency assignment the area of operations is divided into a number of geographical regions. Frequencies for intra-regional working are repeated in each region. For this system to work, two basic conditions must be satisfied:

a. the regions must be sufficiently far apart for a frequency to be used in two regions simultaneously without causing mutual interference; and

b. the overall requirement of either region must not exceed the number of available frequencies.

5. Using this system, the frequencies available to the area are divided into one unique listing and one recurring regional listing. The block of unique frequencies is assigned to area headquarters, lateral links between regions, and area forces or troops who may be required to operate in either region. The listing of recurring frequencies is assigned, with suitable restrictions, to each of the regions. This system is a common method of assigning HF frequencies.

LIST SYSTEM

6. The list system is dependent on formations and units and their supporting communications occupying ground of known and relatively constant frontages and depths. Based on these parameters, frequencies may safely be repeated geographically across the front and from front to rear in an area of operations. Unique lists are provided only for area headquarters and for formations or units that must be able to operate anywhere in the area.

7. The usefulness of this system depends on:

a. Maintaining a given formation deployment for each assignment. Within this deployment, the expansion or contraction of the area, with the consequent dispersion or concentration of radios, can occur without risk of interference subject to satisfying the planning and design limits of the individual classes of radios. The basis for this assumption is that, although the interference levels rise with a reduction in the size of the operational area, there is a corresponding increase in the strength of the desired signal. The opposite effects occur when the area expands.

b. Having moderate conditions of terrain and climate which preclude reaching abnormal ranges, such as may occur with ducting or unwanted sky wave reflections.

c. Possessing detailed knowledge of the requirements and method of operation of the supported formations.

d. Observing a rigid system of priorities in the assignment of optimum frequencies. To be effective, relatively few nets can be accorded exclusive or protected assignments.

8. In this system individual lists are prepared for all types of field formations and supporting arms based on a standard organizational entitlement. Assignments are repeated periodically according to the distances involved and the known groupings. Spare lists are maintained to accommodate changes in grouping. Lists specify the radios by class or type and include the necessary restrictions on power, emission, and antenna type.

9. The list system can provide for an indefinite number of formations' nets; but its efficiency is greatly affected by interference from external signals. Its use is generally restricted to VHF and UHF bands.

RADIO RELAY ASSIGNMENTS

10. Assignment of radio relay frequencies presents a special problem because of the frequency separation required for each transmit and receive link at individual and successive locations. This is further complicated by the operation of a relay grid where additional separation factors must be considered to avoid interference from parallel or adjoining systems.

11. Two general methods are employed to assign radio relay frequencies. These are described in the **Signal Officers Field Handbook**. They are:

a. **Two Block System**. This method is used for a system following a single trunk route and where there are not more than two transmitters and receivers at each site.

b. **Three Point (ABM) System**. This method is employed where there are more than two transmitters and receivers at the same location.

12. In order to allow trunk system engineering in real time, frequency allocation is now carried out through automated aids at the SEP.

CHAPTER 9

POWER SOURCES

SECTION 1

REQUIREMENTS

BATTLEFIELD REQUIREMENTS

1. Signal systems and units require a wide variety of power sources; they are:

    a. medium size power plants for large signal facilities;

    b. small power generators for individual signal detachments;

    c. man portable direct current (DC) generators for light signal detachments;

    d. hand-cranked DC generators for isolated, small signal detachments;

    e. secondary batteries for vehicle or signal system power;

    f. disposable primary batteries for man portable signal equipments;

    g. dry cell rechargeable batteries for some low power requirements; and

    h. lighting kits for field units.

CHARACTERISTICS

2. It is essential that battlefield power sources possess the following characteristics and capabilities:

    a. **Silent Operation**. It must be possible to continue to exploit signal systems under complete silence for short periods of time or during periods of alert.

    b. **Quiet Operation**. As a principle, the closer to the enemy a unit deploys, the quieter its power sources must be. Every effort must be made to screen generators or engine noises. Small generators which are reasonably silent can be suitably buried and screened for forward area operation. Generators not in use must be switched off.

    c. **Infra-Red Signature**. Heat emanating from power generators can be detected by infra-red photography and thermal imagery. Detection may provide the analyst with a radiation pattern which may indicate the size and location of headquarters, administrative centres, signal centres, etc. All efforts must be made to screen these

signatures. Much of the heat radiation can and must be disguised or dissipated by means of suitable camouflage equipments and infra-red reflective shelters. Spacing or dispersion of operating power sources will also reduce the possibility of identification and detection. Finally, activities which produce heat must be controlled and kept to a minimum. These include:

(1) operating vehicle engines,

(2) operating generators of all sizes,

(3) cooking, and

(4) field lighting.

d. **No-Failure Power**. This requirement is applicable to all systems but failure to provide guaranteed power would have a far greater impact on an automated trunk system than on the operations of a radio detachment. In the latter case recourse to the vehicle battery or to a separate battery power source would suffice for a time; however, loss of power for large multichannel systems could drastically affect operations as computerized systems would crash. Provisions must be made to ensure that alternate power sources are available, in place and operationally ready to support important command and control systems. These include:

(1) area trunk communication systems,

(2) ACIS, and

(3) satellite ground stations.

e. **Commonality of Power**. All power sources must be capable of providing 28 Volts DC and all signal equipment must be capable of operation from these sources. This includes field lighting systems which under silent conditions could operate adequately using battery or other silent 28 Volts DC power sources on a limited scale. Proliferation of specialized and dedicated power sources, other than 28 Volts DC must not be allowed to occur because of the obvious necessity to have interchangeable power sources to ensure survivability and flexibility of use.

SECTION 2

POWER SOURCES FOR COMMUNICATIONS

GENERAL

1. All electronic and electrical systems require a source of power. However signal systems demand power sources with a higher standard of reliability and closer control of voltage and frequency than other systems such as lighting and heating. Subsequent paragraphs describe the common types of field power supplies used for signal systems.

2. The major sources of power are:

   a. **Primary Batteries**. These are used in manpack radios, telephones, and small switchboards.

   b. **Secondary Batteries**. These are employed to power most vehicle-borne equipment either directly from a vehicle ignition system or from a separate power supply.

   c. **Generators or Mains Supply**. These are used with facilities requiring large amounts of power, such as signal centres, trunk nodes, etc.

PRIMARY BATTERIES

3. Primary batteries or dry cells are used when small amounts of power are needed and portability is required. They can be readily adapted to provide the various voltages and capacities needed for signal purposes by combining the required number of cells in a power pack of the appropriate size. Leclanche dry cells are discarded when no longer usable. They are light-weight, rugged, and relatively cheap. However, the efficiency of primary batteries decreases rapidly at temperatures below freezing. Leclanche cells have a limited shelf life that can be extended only by refrigeration. However, a recent breakthrough in lithium sulphur dioxide batteries may permit the use of lighter, better and longer lasting primary batteries in the future.

4. Rechargeable power packs can also be used with some signal equipment. But battery charging equipments must be provided with these.

SECONDARY BATTERIES

5. Secondary or storage batteries are batteries which, once discharged, may be restored to their charged state by passing an electrical current through them. The two most common types are:

   a. **Lead Acid Battery**. This type of battery is generally employed to power vehicle engines and generators. It is therefore widely available. Lead acid batteries are heavy and are subject to damage from improper care and handling. They are likely

to leak acid if canted or damaged and the electrolyte will freeze at low temperatures unless kept fully charged.

b. **Nickel Cadmium Batteries**. Sealed nickel cadmium batteries may be used in a number of portable or special purpose applications where small size or more constant performance through a wide temperature range is desired. Compared to lead acid batteries, these cells have a somewhat lower capacity for the same size and weight of battery and, therefore, must be charged more frequently. Additionally, because of the peculiarities of these cells, they usually take longer to recharge and special regulating devices are needed to control the voltage/current values during the recharge cycle. The major advantages of this type of cell lie in its rugged and sealed construction, and in the vastly improved performance at sub-zero temperatures.

6. Fuel batteries or fuel cells are devices that chemically convert the energy available in a fuel directly into electrical energy. Operation is continuous as long as fuel and air (oxygen) are available. They are highly efficient, but in their present state of development both the fuel and the battery components are costly.

7. **Battery Charging**. Batteries can either be transported to a central point for charging or charged at the site where they are used. The former method is effectively employed where a number of stations are collocated or sited within easy driving distance. The latter method is used where stations are widely dispersed or when scheduled delivery cannot be assured.

a. **Centralized Charging**. Requiring a large number of batteries, this method can result in damage through continual handling. However, the operation of a few higher capacity battery charging plants greatly reduces and simplifies the problem of generator operation and maintenance compared to that needed to operate a large number of small generators.

b. **Local Charging**. This method is more reliable in that the operation of the station does not depend on the maintenance of a delivery schedule. However, engine driven generators are noisy and may disclose positions in forward areas or prove objectionable in the efficient operation of a headquarters. When power is provided by a vehicle ignition system, the engine must be run regularly whether the vehicle is driven or not.

GENERATORS

8. **Mobile Generating Sets**. These are employed as a standard source for all field power requirements, as a standby in case of main or common system failure, or specifically to charge batteries. Common types are:

a. **Hand Cranked Generators**. These are provided to recharge batteries, to power small radios which need not be operated on a continuous basis or as an emergency power supply.

b. **Engine Driven Generators**. These are available in a range of power ratings from 500 W to 35 kW.

(1) Smaller generators (under 1.5 kW) usually provide only a DC supply and are used solely for station battery charging.

(2) Larger generators (over 3 kW) are employed to power groupings of associated signal equipment or large individual equipments. In key signal centres an alternate power source is employed to ensure continuity of power supply in the event of failure of the primary source.

9. **Thermo-Electric**. Thermo-electric generators or converters are devices that convert heat energy from the burning of standard fuels directly to electrical energy by means of devices such as thermo couples. They are light in weight, highly efficient, and operate quietly. This type of generator holds considerable promise for the future in the medium power ranges.

PUBLIC UTILITY SYSTEM

10. When circumstances permit, public utility may be employed instead of the mobile, local sources. When employed, the following precautions may be necessary:

a. **Power Control**. Special fusing and voltage regulating devices are needed to ensure a more constant and precise level of supply.

b. **Alternate Sources**. The extent of alternate power capability needed depends on the importance of the circuits being served and the degree of system or circuit disruption acceptable should the primary source fail.

(1) Standby generators are provided for all stations or groupings of signal equipment as an alternate supply.

(2) Alternate power systems that include automatic switching devices are provided for key installations to minimize the period of outage resulting from source failure. This is particularly important for stations operating multi-channel systems. In this case even a minor power interruption is not acceptable because it may cause the loss of many circuits with considerable time being required for restoration.

(3) Where interruptions are not acceptable, banks of batteries may be employed to maintain power during the interval required to switch to the alternate supply.

SECTION 3

ELECTRICAL POWER DISTRIBUTION

POLICY

1. Electrical power is required on the battlefield for a variety of facilities. Some of these facilities have a single power entry point but most have multiple power entry points. As well some facilities have their own power source but others share it and receive their power through a distribution system.

2. The policy for electrical power distribution in the field is based upon the following concepts.

   a. To meet minimum needs until the use of shared power sources become operationally practicable, electrical and electronic systems should be self sufficient in electrical power generation.

   b. As the tactical situation permits, power will be distributed to all elements of a facility from a central source.

POWER CONVERTERS/CONDITIONERS

3. These equipments are required to provide flexibility in the use of generating sets. Stabilized DC will be required for signal installations and for electronic equipment repair and maintenance shops.

4. Power converters will be needed at least until full interoperability of equipment has been achieved. Different voltage and frequency requirements exist for power sources which until now have not been standardized.

POWER DISTRIBUTION

5. A power distribution system provides electrical power from a few large generators. Its transmission system, irrespective of level of deployment is modular. Each module remains flexible in its mode of assembly and its components have the following characteristics.

   a. **Cabling**. Components are standardized in length, current carrying capacity, sockets and plugs.

   b. **Outlets and Connectors**. All plugs and socket connectors are common to generator and distribution network components.

   c. **Distribution Voltage**. Increase or decrease of voltage is done by use of transformer or power conditioners. These can accept the standard types of connectors.

6. The system will be erected on poles, trees, buildings and towers. Laying underground is possible using plough/cable laying trenching equipment.

7. A large power distribution network requires means of control and regulation. When its use is warranted, computer-logic controls giving continuous status readouts of the network are employed. These controls are utilized to ensure proper phase balancing for three phase systems,to allow parallel use of generators when required, to provide minimum break or no-break change-over by use of alternate or standby generators and automatic controls, and to enable quick location and repair of faults in the network.

FIELD LIGHTING

8. Control of lighting in the field is a G3 responsibility. The commander will determine the policy for field lighting in accordance with higher formation orders and his own tactical plan. Field lighting shall always remain a requirement secondary to the need to power the command, control and communications system.

9. The headquarters and signal unit is responsible to provide field lighting for its parent or assigned headquarters elements.

CHAPTER 10

SIGNAL TACTICS IN SUPPORT OF OPERATIONS

SECTION 1

INTRODUCTION

GENERAL

1. This chapter explains the implications of the tactical doctrine for various types of operations on command and control system planning and provides planning guidance for signal officers.

2. The following types of operations will be covered:

   a. offensive operations;

   b. defensive operations;

   c. the withdrawal;

   d. crossing and breaching operations;

   e. airmobile operations;

   f. airborne operations;

   g. amphibious operations;

   h. operations in enemy controlled territory; and

   j. relief in place and passage of line operations.

3. Guidance provided in this chapter does not relieve signal officers from the obligation of making a proper signal estimate and adapting this guidance to the tactical situation at hand.

4. In each section, the scope of the type of operation under discussion will be described; then the major tactical considerations affecting signal planning will be discussed.

SECTION 2

OFFENSIVE OPERATIONS

SCOPE

1. Offensive operations may include the advance to contact, the meeting engagement, the attack and the pursuit. These elements of offensive operations may be conducted in successive or separate encounters.

2. In offensive operations, a commander seeks to seize and retain the initiative by maintaining momentum, keeping the enemy off-balance and preventing him from reacting in a timely and organized manner. Initiative is seized by deceiving the enemy about the location, time and duration of the friendly force thrust; and, it is maintained through shock action, depth in the offence and balance.

3. B-GL-301-001/FT-001 chapter 12 explains how these operations are conducted.

COMMAND AND CONTROL

4. **Advance to Contact**

a. A force in the advance to contact may well be extended in depth and frontage. Distances to be covered will be greater than in most other operations.

b. Physical security of isolated signal elements will be at risk because of the necessity to bypass certain enemy elements. Losses may be higher and more reserves should be maintained. It may be necessary to assign additional protection elements or to collocate with other troops.

c. Passage of information is a vital task of forward elements; yet signal security is critical if friendly intentions are not to be revealed prematurely to enemy electronic reconnaissance troops. Depending on the RECS threat and the commander's emission control policy, means of communication which do not emit in free space (SDS, LOs, line) may have to be used massively. If freely emitting means are allowed, close co-ordination with ESM elements will be required for threat identification and destruction. The forward deployment of the area trunk system will have to be weighed against the risk of trunk node destruction. Use of relays and SCRA may be preferable forward of the FEBA.

d. Unless friendly forces are advancing on well charted and known territory, siting of signal installations and HQ may have to be done with inadequate knowledge of the ground unless signal reconnaissance parties follow closely behind lead combat elements. This may also hamper the automated management of the area trunk system and oblige signal officers to resort to alternate management methods.

e. Commanders will want to move forward either in their rovers or small tactical CPs. This will further complicate the task of signal support for the various HQ components. Movement of main and rear HQ will require careful planning to keep up with a rapid advance.

5. **Attack**

a. In a hasty attack or a meeting engagement, the major command and control consideration is the ability to pass orders quickly and effectively to direct and control the manoeuvre of forces. To do so all major signal systems must be used but effective measures must be taken to counter enemy RECS action.

b. Conversely, in a deliberate attack, security is paramount at least until H-hour. Use of electronic systems must be strictly regulated so as to prevent tipping the enemy on the attack's time, location and objectives. In the mounting stage, maximum use must be made of LOs, SDS and line in preference to radio and radio relay. Emission control directives must be strictly enforced.

c. Once the assault is launched, all means can be used but signal officers must be wary of enemy RECS action and take measures to ensure the effective operations of electronic systems despite enemy electronic deception and jamming.

d. Physical security will remain a major concern for all forward elements until mopping up has been completed during the consolidation stage.

e. Signal officers must foresee the requirement for communications during an eventual exploitation phase and ensure that signal systems can be extended with little or no notice.

f. Commanders will probably move forward in their rovers and tactical CPs. As well, the main HQ must be ready to move forward quickly to keep pace with the progress of forward elements.

6. **Pursuit**

a. In the pursuit, the major tactical considerations affecting signals are the speed of movement, the fluidity of the front and the extended distances.

b. Electronic means of communications will be stretched to the limit and a premium will be placed on timeliness, quick reconnaissance, and short set up and tear down times. The fluidity of the front will demand that calculated risks be taken in regard to the physical security of isolated elements. Extended distances will probably require the use of HF CNR or helicopters for RRB purposes. The trunk system may have to be deployed in a linear configuration along the major axis of the pursuit rather than in the full grid configuration. The insertion of cut-off forces deep in enemy territory will further complicate the task of signal planners. Finally

the need for CSS units to follow the lead elements may well require extensive traffic control communications; the inherent flexibility of the SCRA subsystem should be exploited to the fullest for this purpose.

SECTION 3

DEFENSIVE OPERATIONS

SCOPE

1. Defensive operations are usually undertaken when the enemy has the general initiative in order to prevent him from seizing terrain or breaking through a main defence area. Defensive operations are successful if they succeed in breaking the enemy's attack, destroying his forces and preventing him from accomplishing his aim.

2. Defensive operations are conducted in three stages which may overlap in part:

   a. the covering force stage during which a delay battle is fought to determine the enemy's main axis of advance, to gain time for the preparation of the main defensive position and to weaken the enemy by inflicting casualties;

   b. the decisive battle stage where the main battle is fought from positions within the main defensive area (MDA); and

   c. the countermove stage where depth or reserve forces are moved to block enemy penetration, to counter attack or exploit success in defeating the enemy by maintaining or restoring the integrity of the MDA.

3. B-GL-301-001/FT-001, chapters 13 and 14 explain how defensive operations including the delay, are conducted.

COMMAND AND CONTROL

4. **Covering Force Battle**

   a. A covering force signal officer must have a thorough understanding of his commander's concept of operations. He must be aware of the delay to be imposed, the manoeuvre to be adopted, of the various delaying positions and of the handover arrangements back at the FEBA. Because of the difficult psychological conditions of the delay battle, he will have to ensure his signal troops are briefed in detail to ensure they understand the battle plan they must support and the risks that must be accepted.

   b. Prudent signal officers will carry out intensive reconnaissance of the covering force area (CFA) before the delay battle is joined so as to be in a position to move signal elements quickly and effectively once contact is made and time is critical. In particular, withdrawal routes must be reconnoitred in detail and reserved demolition timings must be known.

c. Liaison must be effected with the MDA signal officer through whose area the final withdrawal must occur so as to coordinate signal control measures at the handover line and for the subsequent passage of line.

d. A force assigned to a covering force role will be extended in depth and frontage. In the initial stage and until physical contact is made with the enemy, the emphasis will be on information gathering. Signal officers will therefore plan for the forward deployment of ESM resources and for a discreet command and control posture. Line, LO and SDS should be used in preference to other electronic signal systems to prevent tipping the enemy prematurely. In developed countries, extensive use should be made of the civilian line system, provided it is possible to encipher transmissions.

e. Once the delay battle is joined, the emphasis must switch to providing commanders with timely and mobile signal support. Electronic signal systems (CNR, trunk) will be necessary to support the rapid deployment of tactical forces from one delay position to the next. At this stage, physical security will also become a problem for isolated signal elements as penetration by forward enemy elements is likely. ECM support will also be required to neutralize the action of forward enemy detachments and to help with the extraction of our own forward forces.

f. The extension of the trunk system forward of the FEBA into the CFA must be carefully weighed against the risk of destruction or the impossibility of withdrawal behind the FEBA and the need for its full exploitation during the MDA battle. However linear extension of the trunk system into the CFA should be possible provided extensive use of SCRA and relays is made to minimize the deployment of trunk nodes forward.

9. Covering forces normally carry out extensive grouping and regrouping from one delay position to the next and effect multiple rearward passages of line. Signal officers must ensure the compatibility of the various systems during these critical stages.

5. **MDA Battle**

a. A signal officer in planning signal support for the MDA battle must reconcile the need for high capacity and resilient communications to allow the extensive coordination required during the defensive battle and the need for extreme discretion until the main battle is joined. During the preparation stage and whilst the covering force battle is going on, radio silence should be enforced in the MDA. This is particularly important for earmarked reserves and counter-attack forces. LO, line and SDS supplemented by some radio relay in the rear area should be the mainstay of communications. Extensive reconnaissance should allow the positioning of signal emitters so as to shield them from enemy electronic reconnaissance elements.

b. Once radio silence is lifted and the main battle is joined, close co-ordination of ESM and fire support elements is required to ensure the neutralization or destruction of enemy RECS/jammers and preserve our ability to effect command and control of our own forces. Communication discipline and skilfully conducted ECCM drills will also be paramount.

c. The MDA signal officer must also take measures to co-ordinate with the covering force signal officer the rearward passage of line by the returning covering force troops.

d. Laying of lines in the MDA will require care and a lot of time if the line grid is to have maximum resilience once the battle is joined. Line reinforcements should be sought from higher formation and line crews should be deployed very early in the preparation stage of the MDA. Whenever possible, the area trunk system should use lines including civilian lines, in preference to radio relay, especially in the forward part of the MDA.

6. **The Countermove Battle**

a. The major signal difficulty at this stage of the battle is to ensure the coordination and the compatibility of signal systems among the rapidly regrouping troops. Troop density will become very high for short periods and at the same time, there will be an extensive need for co-ordination amongst reinforcing, blocking and counter-attacking troops. The planning signal officer must ensure he fully understands the details of all regrouping orders, the manner in which command will be exercised, the critical timings and the adjustments made to the various control measures (axis, boundaries, etc ...).

b. Physical security will become problematic until mopping up is completed if the enemy has achieved infiltration or wide spread penetration. Additional protective measures may be warranted at this stage.

SECTION 4

THE WITHDRAWAL

SCOPE

1. A withdrawal is an operation which occurs when a force disengages from an enemy in accordance with the will of its commander. A withdrawal is successful when the force achieves a break away and establishes itself in a new position in order to execute a new task.

2. A withdrawal takes place in four stages, which overlap in part:

   a. thinning out of the position to be evacuated;

   b. preparation of intermediate and new positions;

   c. disengagement of the main body; and

   d. protective and delaying action by the covering force.

3. B-GL-301-001/FT-001 Chapter 15, explains in detail how withdrawals are conducted.

COMMAND AND CONTROL

4. **General**

   a. Since the enemy will have the initiative, it is extremely difficult to maintain security and achieve surprise. Signal officers must participate in the planning of withdrawals as early as possible so as to take measures to put in place an effective signal security plan. In particular, traffic patterns must not betray the intentions of the commander and electronic deception must be used to achieve surprise and deceive enemy electronic reconnaissance.

   b. Maintenance of morale is critical, especially for isolated signal elements who may get the feeling of "having been forgotten behind". Sound signal management may well require the reinforcement of signal leadership elements with forward isolated elements at the very time when leaders are required in the forward position as well as in the new position to the rear.

5. **Thinning Out Stage**

   a. Signal reconnaissance must start during this stage. Security requirements may force the reconnaissance to be conducted at night or under conditions of poor visibility, so additional resources may have to be devoted to this task to offset the slower pace of activity. Reconnaissance has to take into account the total distance to be covered, the going on the withdrawal routes, demolition timings, withdrawal

timings, intermediate positions, defiles if any, and the possible sites for signal installations. Care should be taken to screen signal installations from enemy electronic reconnaissance.

b. It may well be necessary to send back for this task the second in command of all signal elements involved. This will place an additional burden on leadership elements in the forward area.

6. **Preparation**

a. During this stage, the signal infrastructure for the withdrawal is put in place. Radio silence should be enforced to the rear of the position to be evacuated. The trunk system should be deployed axially along the withdrawal routes but line rather than radio relay should be the main transmission means if at all possible.

b. An important traffic control communication system will have to be established. It should be based on LOs and MPs at various check points using secure telephone, SDS or SCRA. CNR should only be a last recourse.

c. In all likelihood, signal support for a withdrawal will exceed the capability of the withdrawing force. Reinforcements by the superior formation signal officer will be required.

d. Signal systems in the position to be evacuated must continue to be used in a normal pattern so as not to raise enemy suspicion. Dummy stations may have to be set up to deceive the enemy during the preparation stage; but this must be carefully coordinated with G2/G3 and higher formation staffs.

7. **Disengagement**. In the early stage of the disengagement, the electronic part of the deception plan should move into full gear in conjunction with other elements of the plan. However, this will not likely succeed very long and the signal officer must be ready to use all electronic signal systems to provide signal support once the withdrawal is uncovered and the delaying battle is joined. In particular ESM and ECM resources will be required to neutralize enemy command and control and augment the delay imposed.

8. **Delaying action**. During this stage, the signal problem is similar to that of the covering force battle already explained in Article 1005.2. above.

SECTION 5

CROSSING AND BREACHING OPERATIONS

SCOPE

1. A crossing or breaching operation involves the crossing or breaching of a natural or artificial obstacle by a military force in order to continue movement in support of operations. Crossing and breaching operations can occur during offensive, defensive and delaying operations, during passages of line, in the forward or in the rear combat zone. A crossing refers to the opening of a route over a water obstacle, while a breaching refers to the securing of a passage through a land obstacle.

2. There are two types of crossing/breaching operations.

   a. **Hasty**. This operation takes place from the line of march with little preparation.

   b. **Deliberate**. This operation requires extensive preparation and is only undertaken if a hasty crossing cannot be achieved. This is the type of operation considered in this section.

3. A crossing operation is done in four stages:

   a. reconnaissance;

   b. assault to gain lodgment;

   c. build up of the bridgehead; and

   d. consolidation before the break out.

4. A crossing force is normally organized as follows:

   a. a force in place, to hold the near bank;

   b. a bridgehead force, to make the assault and establish the bridgehead;

   c. a break out force to continue operations beyond the bridgehead;

   d. a traffic control organization to direct traffic on both sides of the obstacle; and

   e. a crossing area organization to establish and operate the crossing sites.

5. CFP 301(1) Chapter 16 explains in detail how obstacle crossings and breachings are conducted.

COMMAND AND CONTROL

6. **General**. Since a crossing or breaching operation is a subsidiary part of other types of operations, the tactical considerations for these types of operations must also be taken into account; however, only those aspects peculiar to crossing and breaching operations shall be discussed here.

7. **Reconnaissance Stage**

a. During this stage, signal officers must reconnoitre carefully all areas where communications for the crossing force must be put in place. The enemy threat against the crossing and the terrain largely dictate the means of communications to be used. It is unlikely that complete surprise can be achieved. Line and SDS should be used for the traffic control and crossing area organizations so as not to tip off the enemy as to the exact crossing place and timing.

b. Complete radio silence should be maintained by the crossing force until the battle is joined. Thereafter the trunk system should be used in preference to CNR for the crossing and traffic control organizations.

c. ESM resources will be useful at this stage to locate enemy forces on the far side.

d. In cases where the force in place belongs to another formation, the signal officer must make the necessary co-ordination arrangements to ensure an efficient forward passage of lines.

e. The communication infrastructure for the crossing should be put in place as soon as the force in place has been established on the near side of the obstacle and in time to control the advance of the assault force through the crossing area.

f. Signal resources required for this task are extensive and will have to be made available by regrouping the resources of various units in the formation, such as reconnaissance units, MP units, signal resources of the force in place, signal resources of the controlling HQ, etc.

g. If sufficient resources are available, electronic deception may be used to deceive the enemy as to the place and time of the crossing.

8. **Assault Stage**

a. Signal support for the assault force relies mainly on its integral resources supplemented as required by the crossing formation trunk system resources.

b. Provision has to be made for its passage of line through the force in place and for its co-operation with the traffic control organization which it will direct until the

full crossing area is established, after a lodgment is seized on the far side of the obstacle.

c. As for the deliberate attack, communications should be discreet before H-hour; thereafter radio silence can be lifted at the discretion of the assault force commander.

d. As soon as intermediate objectives are seized, the crossing area is established and the traffic control reverts from the assault force commander to the crossing force commander.

9. **Build Up and Consolidation of the Bridgehead**

a. During this stage, the major concern of the bridgehead force signal officer is to ensure that sufficient EW and communication resources cross the obstacle to permit the orderly support of the consolidation and break out stages.

b. A balance must be kept between overcrowding the far bank with superfluous signal resources and keeping enough resources to offset equipment losses and casualties and to allow the support of subsequent stages of the operation.

c. The bridgehead force signal officer must also make the necessary preparations for a forward passage of line by the break out force.

d. The bridgehead is extremely vulnerable at this stage and maximum use of EW resources must be made to locate and neutralize or destroy enemy command and control elements. As soon as possible, alternate signal systems to CNR must be used on the far bank to lower the electronic profile of our own command and control system.

e. Physical security will also be low until mopping up is complete during the consolidation phase.

SECTION 6

AIRMOBILE OPERATIONS

SCOPE

1. An airmobile operation is the movement of combat forces and their equipment about the battlefield in air vehicles under the control of a land force commander to engage in ground combat. It can be undertaken separately or as part of any type of ground operations. An airmobile force can be employed independently or in conjunction with other land forces.

2. Airmobile operations are planned in the reverse sequence of their execution as follows:

   a. a ground tactical plan to cover the employment in the objective area once the lifted force is landed;

   b. a landing plan, to place the lifted force in the objective area;

   c. an air movement plan to fly the lifted force to the objective area; and

   d. a mounting plan to assemble ground and aviation elements before take off.

3. B-GL-301-001/FT-001, Chapter 17, explains in detail how these operations are conducted.

COMMAND AND CONTROL

4. **The Ground Tactical Stage**

   a. Signal support during this stage is the responsibility of the airmobile force signal officer. In order to carry out his task, he has to know the enemy RECS threat en route and in the objective area, the distance from the landing zone to the objective area, the quantity and size of signal resources allowed to be flown in (vehicular or manpack only), the arrangements made by the superior commander's signal officer for communications with supporting forces (link up forces, artillery, air forces) and the method of extraction of the airmobile force.

   b. Before the main body of the airmobile force is inserted, it could be necessary to insert pathfinders for the reconnaissance of the objective area and marking of the landing zone (LZ). In such a case, special signal arrangements must be made for the pathfinders to report back and for recognition signals in the LZ.

   c. As a matter of principle, radio silence should be maintained in the objective area as long as possible or at least until H-hour. When used, radio transmissions should be short and code words used to report completion of activities so as to prevent DF by enemy forces.

d. If link up of the airmobile force with a main ground force is planned, the superior commander's signal officer will make the necessary co- ordination between the two elements during the mounting stage.

e. Once the ground operation is on and radio silence has been lifted, an airborne CP cold be used to co-ordinate the movement of all components and relay back to superior HQ reports and requests for support, if the air situation is favourable and the AD threat from the ground is negligible.

5. **The Landing Stage**

a. During the landing stage, the communication system for the ground tactical stage must be on stand-by, ready for use. Signallers in aircraft and disembarking should be on listening watch ready to receive orders. DRs should accompany selected commanders ready to transmit their orders to various points on the LZ or to another LZ. Arrangements for contact with the pathfinder group should be executed. This is particularly critical if Us are unmarked and guidance from the LZ to the objective area is required.

b. Enemy reaction on the LZ may require breaking radio silence either by the ground troops or by the aviation unit.

c. Signal resources in personnel and equipment should have been dispersed in various aircraft along with the various command elements to ensure adequate back-up in case of destruction during the air move.

6. **Air Movement Stage**

a. The airmobile force signal officer should help the aviation component signal officer prepare the signal plan for this stage. Ideally the flight to the objective should be silent but it may be necessary to co-ordinate with accompanying EW helicopters, armed helicopters and close support aircraft for air space control and suppression of air defence en route. It will also be necessary to decide on permissible active navigational aids.

b. Planning for air movement also includes planning for the return of aircraft after the insertion and for the extraction sorties if a link up is not planned. The decision to be electronically silent on the various flights in and out depends on the mission security requirement, on the enemy threat and, for the extraction flights, on the immediate tactical situation at the time of extraction.

c. During the air movement stage, signals must arrange for intercommunication between ground and aviation commanders so that the ground commander can be made aware of tactical developments as they occur.

7. **Mounting Stage**

a. As for any other type of operations, supporting signal officers must have an intimate knowledge of their commander's intentions and plans. But since three separate components are involved, it is of the utmost importance that complete co-ordination between these components' signal plans be effected (superior command, ground component and aviation component).

b. The superior commander's signal officer must take the lead in planning and coordinating. Before the superior commander's orders are issued, he must put together the major elements of the signal plan between the airmobile force and the outside world. Then once the airmobile task force is formed, he should get together with the airmobile force signal officer and the aviation component signal officer to explain clearly how he intends to provide signal support to the airmobile force and what are the constraints under which all must operate.

c. The airmobile force signal officer is also the land component signal officer. He therefore has a dual responsibility for planning the signal support internal to the ground component and also to co-ordinate the signal support between the aviation component and the land component.

d. The aviation component signal officer prepares the aviation signal plan within the constraints imposed by the airmobile force signal officer.

e. Once planning is complete, and marshalling is done, the airmobile force signal officer should ensure that a complete signal briefing is given to all signallers and key land and aviation commanders and staff officers. Equipment should also be inspected and tested for serviceability.

f. The mounting stage should normally be conducted under complete electronic silence within the airmobile force, except for short (burst) pathfinder reports if necessary. However communications of host elements will have to be used to link the various commanders and the supporting elements during this stage.

SECTION 7

AIRBORNE OPERATIONS

SCOPE

1. An airborne operation is a joint operation involving the air movement of ground forces into an objective area to seize and hold an objective, to interdict an area or to conduct a raid. Airborne operations can be conducted independently or in conjunction with other land forces.

2. Airborne operations like airmobile operations are planned in the reverse sequence of their execution as follows:

   a. a ground tactical plan, to cover the employment once the forces have landed;

   b. a landing plan, to organize the manner in which the ground forces will arrive on the drop zones (DZ) in the objective area;

   c. an air movement plan, to fly the force to the objective area;

   d. a mounting plan, to assemble army and air force resources and load the aircraft at departure airfields.

3. B-GL-301-001/FT-001 chapter 18 and B-GL-310-001/FT-001 explain in detail how these operations are conducted.

COMMAND AND CONTROL

4. **General**

   a. In many ways, airborne and airmobile operations are similar and the supporting signal officers face very similar problems in both cases. This section provides guidance only for additional aspects peculiar to airborne operations. It should therefore be read in conjunction with Section 6.

   b. In airborne operations, security and intelligence are indispensable to success. Therefore signal officers have to take strict measures to ensure that signal planners disseminate information on a strict need to know basis. Briefings to troops occur only once all elements are mustered and quarantined on the departure airfields. Equally important, higher formation EW resources must be fully exploited to gain maximum signal intelligence for exploitation during the various stages of the operation.

5. **The Ground Tactical Stage**

a. If one replaces the expressions "airmobile" and "LZ" by airborne and "DZ", guidance given at Section 6, Article 1010.2 is also valid for airborne operations planning.

b. The major difference between airmobile and airborne operations is probably the depth of insertion into enemy territory. Airborne forces will usually be inserted deeper than airmobile forces. Consequently the communications back to superior HQ and to external supporting forces will be done over much longer distances and require different means.

c. The airborne force signal officer must also be aware that immediately after landing, the airborne force is extremely vulnerable and that the ground commander will want to ensure that regrouping of forces into fighting formations is done as expeditiously as possible. Depending on the conditions after landing, the airborne force commander may wish to break radio silence in order to speed up regrouping. Cohesion of the tactical force would thus take precedence over security.

d. Finally the airborne force signal officer must plan for A/G/A communication and DZ control during follow up resupply missions.

6. **The Landing Stage**

a. Same guidance as for airmobile operations. However signal officers must be ready to react to adverse conditions immediately after landing. The likelihood of destruction and casualties in flight and on landing and of inacceptable dispersal on and off DZs may jeopardize the signal plan.

b. In advising airborne commanders on emission control policy on arrival in the objective area, signal officers must carefully weigh the threat, the need for rapid direction if the plan must be changed and the overwhelming need for a rapid concentration of force immediately after landing. If the plan develops as expected and surprise is achieved, retaining radio silence as long as possible may be worthwhile. In this case, DRs could be used provided they are well briefed on the relative positions of the various DZs and have some means of transport (bicycles or motorcycles).

7. **Air Movement Stage**. Same guidance as for airmobile operations. During this stage, EW aircraft could accompany the transport aircraft to neutralize air defence and surveillance radar en route and in the objective area. The task force signal officer should be ready to advise the airlift commander on this aspect.

8. **Mounting Stage**

a. Same guidance as for airmobile operations only change the "superior commander's signal officer" for "joint task force signal officer", the "airmobile force signal officer" for "airborne force signal officer" and the "aviation signal officer" for "airlift force signal officer"

b. Prior to airborne operations, not only briefings but also rehearsals must be conducted. The airborne force signal officer will ensure that the complete signal plan is rehearsed and "walked through". Inspection of rigged signal equipment must also be carried out in detail.

c. Because of the higher rate of casualties right at the outset, the airborne force signal officer will ensure that his plan includes the requirement for a small reserve of personnel and equipment in the initial assault as well as in the immediate follow up resupply drops.

SECTION 8

AMPHIBIOUS OPERATIONS

SCOPE

1. An amphibious operation is a joint operation involving the sea movement of naval, land and air forces into an objective area to conduct an amphibious assault/landing on a hostile shore; or, an amphibious raid or an amphibious demonstration. Alternately it could also involve an amphibious withdrawal which is the extraction of a land force from a hostile shore by naval forces. Such an operation may be conducted independently or in conjunction with other land forces.

2. Amphibious operations are normally planned in five stages and in the reverse sequence of their execution.

a. **Assault**. This stage starts with the arrival of the amphibious task force in the objective area and ends when the mission of the amphibious task force is accomplished.

b. **Movement**. The components of the amphibious task force move from the points of embarkation to the amphibious objective area.

c. **Rehearsal**. During this stage, the plans, including the signal support plan, are tested and practised.

d. **Embarkation**. This covers the period during which troops and their equipment are embarked in assigned shipping.

e. **The Planning Stage**. This covers the period from the issue of the initiating directive by a superior commander to the embarkation of forces.

3. B-GL-301-001/FT-001, chapter 19 and ATP-8 explain in detail how these operations are conducted.

COMMAND AND CONTROL

4. **General**

a. An amphibious task force is a joint force but it will always be led by a naval officer.

b. The key command and control appointments from a signal point of view are:

(1) naval amphibious task force commander and his naval communication officer;

(2) landing force commander and his signal officer; and

(3) air force commander and his communications-electronics officer.

c. Signal planning must encompass communications required for the command of the amphibious task force as a whole; for lateral communications between the naval, land and air components; and for communications internal to each component. Responsibilities are shared as follows:

(1) the amphibious task force signal officer plans signal support for the task force as a whole and co-ordinates requirements for communication between components and between the task force and external supporting forces;

(2) the landing force signal officer plans signal support for the land component and co-ordinates all signal requirements for operations once the force is landed; and

(3) the air force communications- electronics officer will plan the signal support for air force elements integral to the task force.

d. The critical signal planning element is in providing the amphibious task force commander and the land force commander the required signal support afloat and ashore, and to effect an orderly transfer of the landing force commander's CP from sea to shore without discontinuity. Signal planners must be aware and plan for basic differences in signal doctrine, procedure and equipment between the three services.

5. **Assault Stage**

a. The formulation of an assault concept of operations is the first step in the overall planning process. The landing force signal officer must participate in this process and co-operate closely with the task force communication officer to ascertain whether the concept can be supported by communications ashore and afloat.

b. Signal support for operations ashore is conducted as for other offensive operations except that the signal plan must:

(1) provide for an early build up of signal systems ashore;

(2) provide for an orderly transfer of command and control of the landing force from afloat to the beachhead;

(3) provide for the land force commander to command initially from a joint CP afloat with the task force commander;

(4) provide EMC between naval, air and land signal systems on the initial stages of the assault when all systems are operated from ships;

(5) integrate the requirement to operate rear and lateral links from shore to the naval task force CP afloat and to supporting air force elements afloat or on land beyond the objective area; this includes complex landing ship and beach control communications;

(6) where link up with other ground forces is planned, include the requirement for communication during link up;

(7) where extraction by sea is planned, include the reverse of the process explained in (1) to (5) above; and

(8) when subsequent operations on land are planned, include the provisions for a forward passage of line by follow-on forces.

6. **Movement**. During this stage, landing force signal systems should be silent. Naval force communications should be used when necessary and if naval emission control policy allows.

7. **Rehearsal**. Amphibious operations are complex and require rehearsals. Supporting signal officers must ensure that all aspects of the signal plan are rehearsed and adjustments made where necessary. This provides an opportunity to test the understanding of the plan by all concerned. Rehearsal requirements must be foreseen in the distribution of equipment and personnel among ships during embarkation.

8. **Embarkation**

a. Signal officers should appoint somebody to ensure that all signal personnel and equipment are embarked and distributed among shipping so as to allow the orderly transfer from ships to landing craft in the objective area.

b. If an enemy threat is foreseen during the movement phase, crossloading of signal equipment and personnel should be planned to overcome losses or destruction.

9. **Planning**

a. Unlike other types of operations, the landing force commander, one of the subordinate commanders, assumes a pre-eminent role during this phase. The amphibious task force commander merely acts as a coordinator to ensure all other elements of the task force take effective measures to support the landing force commander's concept of operations.

b. This relationship ceases upon the start of embarkation when the task force commander assumes overall command responsibility.

SECTION 9

OPERATIONS IN ENEMY CONTROLLED TERRITORY

SCOPE

1. Operations in enemy controlled territory include:

    a. **Operations by Encircled Forces**. These in turn include the defence of the encircled force and its break out.

    b. **Link Up Operations**. This occurs when a force joins another friendly force in enemy controlled territory.

    c. **Special Operations**. These are operations conducted by special troops in order to attack or disrupt vital points or to secure important information deep behind enemy lines.

2. B-GL-301-001/FT-001, chapter 20 deals with these operations in detail.

COMMAND AND CONTROL

3. **Operations by Encircled Forces**

    a. Encirclement is not a planned activity but one with which military commanders may have to cope. Once a force has been encircled, the first priority is to re-establish the integrity of the command and control system in the pocket including its signal element in order to plan and direct the immediate defence of the forces encircled.

    b. Once the defence is organized, the signal officer must attempt to lower the electronic profile of the signal system in order to avoid RECS attack and avoid DF of critical command and control elements. If at all possible, line and SDS should be used in preference to radio during the defensive stage of the encirclement. However in the event of an attack, CNR may have to be used especially by the reserve/counter-attack force.

    c. The signal officer must also try to re-establish communications with the superior commander outside the pocket so that relief, break out, combat support and combat service support may be coordinated. If it is not possible electronically, the exfiltration of a messenger, DR or LO should be considered.

    d. If a break out is planned, the signal officer must ensure that absolute signal security is maintained until H hour in order to achieve surprise; this may conflict with the need for co-ordination with external forces. A decision to co-ordinate by radio will depend on the relative importance of surprise and support from external

forces, and on the quality of signal security procedures (crypto systems and traffic patterns). Once the break out starts, all signal means available are used to ensure immediacy of control and maintenance of the momentum. If at all possible, the signal officer must co-ordinate frequencies, authentication systems and recognition signals between the encircled troop lead elements and the external friendly forces with whom it is planned to establish contact.

4. **Link-up Operations**

a. A link-up operation is planned much like a normal attack or advance to contact, but specific aspects of command and control between the two converging forces need explanation.

b. The guiding principles for the planning and conduct of link-up operations are security to achieve surprise, speed to prevent timely enemy reaction and coordination of manoeuvre and control measures to prevent useless friendly casualties.

c. The superior commander's signal officer is responsible for co-ordinating signal support between the two converging forces; once this is done, the link-up force signal officer must take the initiative to establish contact with the static force. In all likelihood, CNR will be the only means of communications with the force in enemy territory, so precautions must be taken not to tip the enemy about link-up plans.

d. As for break out operations, co-ordination between converging forces must cover passwords, frequencies, code keys, contact location, timings and visual signals.

5. **Special Operations**

a. Special operations teams operating behind enemy lines are equipped with special, long range, secure radio communication equipment to contact their controlling HQ.

b. Sigsec measures may include:

(1) varied calling schedules;

(2) varied frequency plans;

(3) burst transmission;

(4) use of low power transmitters in the operational area and highly sensitive receivers at the controlling HQ; and

(5) remote radio transmitters away from the operational base or CP.

SECTION 10

RELIEF IN PLACE

SCOPE

1. Relief of troops includes operations whereby combat activities are taken over by one force from another. There are two types of relief operations:

   a. **Relief in Place**. An operation in which all or part of a force is replaced in a sector by an incoming unit which takes over operations at this point.

   b. **Passage of Line**. An operation in which a force moves through another force either to come into (forward passage), or out of (rearward passage) contact with the enemy.

2. B-GL-301-001/FT-001 chapter 21 explains how these operations are conducted.

COMMAND AND CONTROL

3. **General**. Relief operations are delicate operations because of the inherent danger of congestion, confusion and the co-existence of two parallel command and control systems within one area. To ensure success, liaison at all levels between forces must be established and deception, including electronic deception, and signal security must prevent enemy interference. The incoming and outgoing signal officers must start planning early and ensure the closest coordination between their two elements.

4. **Relief in Place**

   a. In a relief in place, the outgoing signal officer is concerned with:

      (1) signal security by maintaining the right patterns of traffic and personnel shift changes on radio;

      (2) making provisions for the reception and briefing of incoming signal troops;

      (3) maintaining the in-place signal systems for as long as possible, this is especially critical for CNR, other systems (trunk, line, SDS) can be taken over gradually by the incoming signal officer until only the CNR is left;

      (4) extricating his signal personnel and equipment after handover has been done;and

      (5) coordinating with the superior signal officer, the signal plan for his next position.

b. The incoming signal officer is concerned with:

(1) signal security by remaining electronically passive until as late as possible in the relief procedure, this is especially true of CNR operations;

(2) making provision for the early reconnaissance and coordinating take over with the outgoing signal officer;

(3) introducing his signal personnel and equipment gradually starting with SDS, line, trunk and CNR; and

(4) taking over as late as possible during the relief operations.

5. **Forward Passage of Line**

a. The moving force signal officer is concerned with:

(1) ensuring signal security by remaining electronically passive until H hour;

(2) planning early reconnaissance and coordinating with the in- place signal officer;

(3) collocating his key signal personnel with the in-place key signal personnel early in the passage of line so as to ensure a smooth passage; and

(4) extending the higher formation signal system beyond the line of departure as coordinated with the superior signal officer.

b. The in-place signal officer is concerned with:

(1) ensuring signal security by maintaining the right pattern of traffic on electronic systems;

(2) making provisions for the reception and briefing of the moving force key signal personnel;

(3) making provisions for traffic control communications during the passage of line;

(4) maintaining the in-place signal systems until the passage is complete; and

(5) initiating signal planning for his commander's next mission after the passage of line.

6. **Rearward Passage of Line**

a. The moving force signal officer is concerned with:

(1) signal security behind the handover line where his force should become electronically silent as soon as disengagement is achieved;

(2) making provision for early reconnaissance and liaison with the in-place signal officer;

(3) collocating key signal personnel with the in-place CP early in the passage of line so as to ensure a smooth passage; and

(4) coordinating with the superior signal officer for the signal plan in the new rearward position.

b. The in-place signal officer is concerned with:

(1) signal security by maintaining radio silence until contact is established at the handover line;

(2) making provisions for the reception and briefing of the moving force signal personnel; and

(3) making provisions for traffic control communications during the passage of line.

CHAPTER 11

SIGNALS IN UNIQUE ENVIRONMENTS

SECTION 1

INTRODUCTION

GENERAL

1. This chapter provides guidance to signal officers supporting forces operating in unique environments.

2. The following environments will be covered:

   a. operations in a nuclear, biological and chemical (NBC) environment;

   b. operations in built-up areas (Section 3 to follow);

   c. operations in forests (Section 4 to follow);

   d. operations in mountains (Section 5 to follow);

   e. operations in the arctic and cold weather (Section 6 to follow);

   f. operations in jungles (Section 7 to follow); and

   g. operations in deserts (Section 8 to follow).

SECTION 2

OPERATIONS IN AN NBC ENVIRONMENT

THE NBC ENVIRONMENT

1. B-GL-301-001/FT-001, Chapter 12 describes the threat, the general effects and the general method of defence against NBC weapons. This section will deal more specifically with the impact of this environment on signal activities.

EFFECTS OF NUCLEAR WEAPONS ON SIGNAL EQUIPMENT

2. Aside from the devastating results of a nuclear explosion, there are other effects that could have an impact on signal equipment even at great distances away from ground zero. These a re:

a. electromagnetic pulse (EMP); and

b. nuclear blackout.

3. **EMP**. EMP originates with the release of massive charges of Gamma rays, X-rays and neutrons in the atmosphere. The pulse of electromagnetic radiation released by a nuclear explosion is many times stronger than that of lightning; as a result, it can enter signal equipment through antenna systems, power connections and signal input connections. Solid state circuitry is particularly susceptible to damage; spares and spare parts should be kept in steel boxes or shielded whenever possible. The following paragraphs describe the effects of EMP on different means of communications as well as the actions to be taken to minimize damage:

a. **Radio**. The first protective measure is to disconnect the antenna. Equipment, power and antenna connectors should be disconnected when the radios are not in use or during periods of radio silence. Equipments should be shielded from direct penetration of EMP whenever possible.

b. **Multi-channel Radio**. EMP will likely damage the sensitive receivers. In order to minimize damage, all spare equipment should be disconnected from the antennas and from power and signal cables. Planning should stress shielding equipment whenever possible, flexibility in routing and re-routing critical circuits, and allow for spare equipment to minimize the likelihood of losing entire systems.

c. **Line**. Non-shielded line and cable is susceptible to arcing and insulation failure. Replacement and repair is required after EMP exposure. Shielded cable should be grounded at one end and cable shield connectors must be inspected frequently to ensure proper connection. Cables and lines between equipments can become unintentional antennas; this can be avoided by:

(1) keeping the lengths of cable and line as short as possible (the amount of energy collected is directly related to the length of the conductor);

(2) burying all cables and lines, including power cable, at least 1 m deep;

(3) never leaving line or cable coiled on a reel connected to equipment (the coil will pick-up more energy than a straight cable run);

(4) always using a common ground for all equipment, shelters and power sources; and

(5) ensuring that all antenna guy lines are properly insulated and grounded.

d. **Visual and Sound**. Should EMP cause the loss of radio and line communications, the use of visual and sound signalling may be necessary for command and control.

e. **SDS**. Extensive use of SDS, courier and liaison may be necessary in a nuclear environment when and where equipment has been damaged by EMP.

f. **Shielding**. Direct penetration of EMP into signal equipment is prevented by shielding. Shielding effectiveness is related to the type of shielding and its thickness. For effective electrical field shielding, any metal can be used. For magnetic shielding, iron or steel is required. Loss of otherwise good shielding is due to openings, such as doors, panels and vents in the shield enclosures. Other conductors, such as water pipes and cooling and heating ducts, also provide good access paths for EMP penetration. In order to minimize the effects of direct penetration of EMP, all access panels and other equipment apertures should be closed and sealed at all times, except when they absolutely must be removed or opened for operation or maintenance. Where feasible, signal equipment may be buried 1 m deep, in soil, to reduce the effects of EMP.

4. **Nuclear Blackout**. A nuclear blast always produces large disturbances in the atmosphere. For airbursts, below an altitude of 25 km, the most significantly disturbed region is within a well-defined fireball varying from one km to tens of km. For underground blasts or at very low altitudes, large dust clouds are generated in addition to the fireball. When a radio transmission goes through a nuclear blast region, there will be degradation of the radio wave that results in the partial or the total blackout of radio communications. The characteristics of this blackout, as well as actions to minimize its effects, are described below.

a. **Nuclear Blackout Variables**. The three variables of nuclear blackout that concern communications are:

(1) altitude and direction of the nuclear blast,

(2) yield of the weapon, and

(3) frequency of the radio waves.

b. **Radio Waves Interactions**. The basic interactions of radio waves with the nuclear fireball and the dust created by the blast are refraction, absorption and scattering. As a result, signals arriving at the receiver will vary rapidly in phase, strength and in direction of arrival. The three phenomena may occur singly or concurrently. In addition, the fireball will radiate thermal noise. In the case of tactical radio systems, HF to SHF may be enormously affected by these radio wave interactions.

c. **Blackout Environment**. The actual amount of blackout interference likely encountered on the battlefield will not be known until a nuclear war occurs. However, in such an environment it can be expected that three main combinations would cause blackout for varying periods of time. They are:

(1) high altitude blasts and synchronous satellite relays,

(2) high altitude blasts and HF communications systems (skywave), and

(3) dust clouds produced by low altitude blasts and line of sight communications systems.

d. **Remedial Actions**. When blackout occurs, the following actions may reduce communication outage time:

(1) line communications which have not been affected by EMP may be used,

(2) alternative routing or relaying around the blackout region may be possible, and

(3) assigned alternative frequencies may be used. (If it is suspected that interference is being produced by an ionized region, higher frequencies should be tried first but when dust appears to be the problem, lower frequencies should be tried).

EFFECTS OF BIOLOGICAL AND CHEMICAL WEAPONS ON SIGNALS

5. Continuity of command and control is essential during periods of gas or chemical attacks. Signals will play a vital role in:

a. rapid collection and dissemination of information related to enemy capabilities, location and use of biological and chemical resources;

b. warning of own troops and those of flanking formations of attacks, impending attacks (if possible), and contaminated areas.

6. Biological and chemical agents are primarily anti-personnel weapons. The survivability of command and control systems is therefore dependent on the ability of personnel to survive and to operate and maintain these systems in a reliable manner. Survival of personnel is dependent on:

a. personal protection measures; and

b. collective protection.

7. **Personal Protection**. Personal protection is achieved mainly by wearing protective masks and clothing. The use of radio and telephone communications will be difficult even when aided by special types of ancillary equipment. Moreover, problems will also arise in the operation of keyboard equipment, handling of messages, maintenance and repair of systems, etc. Signal personnel, as well as users, must be highly trained in the use of protective clothing and equipment and be capable of effectively carrying out their responsibilities while wearing such clothing.

8. **Collective Protection**. Collective protective measures for CP personnel is possible through the provision of overpressure shelters in which personnel can continue to carry out all necessary actions needed for the operation of the command and control system. The shelters may be of permanent or field construction, depending on location and the tactical situation, but should contain special air filtration and circulation plants. Operators and users will require suitable airlock entrances and exit facilities for prolonged operations.

9. **Decontamination**. The need for decontamination significantly affects any operation plan. The commander has to decide on the degree of decontamination to be achieved and on the control measures to be adopted. Priorities for decontamination must be laid down clearly; initial measures being limited to those essential for operations to continue. Methods and levels of decontamination, applicable to both personnel and equipment decontamination, can be found in the B-GS-316 series of manuals.

10. **Reserves**. A reserve of personnel and equipment must be available to signals to reestablish any part of the command and control communications systems rendered inoperative by an enemy NBC attack, either through destruction or contamination.

SECTIONS 3-8

These sections will not be written until the relevant GS doctrine manuals have been written.

ANNEX A

SIGNALS REFERENCES AND STANDARDIZATION AGREEMENTS

1. **Tactical Doctrine Manuals** - The following publications are related to and may be used in conjunction with this manual:

a. **Canadian Forces**

(1)	B-GL-302-002/FP-002	Specific Operations, Vol 2, Arctic and Sub-arctic Operations, Part 2, Northern Operations
(2)	B-GL-302-004/FP-002	Specific Operations, Vol 4, Part 1, Jungle Operations
(3)	B-GL-302-005/FP-002	Specific Operations, Vol 5, Mountain Operations, Part 1, Tactics
(4)	B-GL-302-010/FP-001	Specific Operations, Vol 10, Parachute Operations
(5)	B-GL-303-002/FP-001	Staff Manuals, Vol 2, Operational Staff Procedures
(6)	B-GL-303-003/FP-000	Staff Manuals, Vol 1, Command and Control of Land Forces
(7)	B-GT-D35-001/AG-000	Frequency Management

b. **NATO**

(1)	ACP-122(D)	Communications instructions - security
(2)	ATP-8	Doctrine for amphibious operation
(3)	ATP-27(B)	Offensive air support operations

2. **Standardization Agreements** - The following international Standardization agreements have been wholly or partially incorporated into this volume:

a. **STANAG** (operational standards)

STANAG	QSTAG	ASCC Air Std
2014 Ed 5, Amdt 3	243 506	Operations orders, warning orders and administratives orders
2028 Ed 4	513	System for field cable or field wire labelling
2035 Ed 5	517	Signing of HQ and installations
2101 Ed 5 Amdt 2	533	Principles and procedures for establishing liaison
2113 Ed 3, Amdt 2	534	Destruction of military technical equipment
5018 Ed 1, Amdt 4		NATO manual interface between the manual switched telecommunications systems of the combat zone.
5040 Ed 1, Amdt 1		NATO automatic and semi-automatic interfaces between the national telecommunications systems of the combat zone and the NATO integrated communications systems.
5042 Ed 1, Amdt 5		Telecommunications diagram symbols.
5046 Ed 1, Amdt 2		The NATO military communication directory system.
5048 Ed 2, Amdt 2	522	Principles and procedures for establishing the minimum scale of communications for the use of NATO land forces.
6004 Ed 2, Amdt 1	354	Standard interference and jamming warning report.

ANNEX B

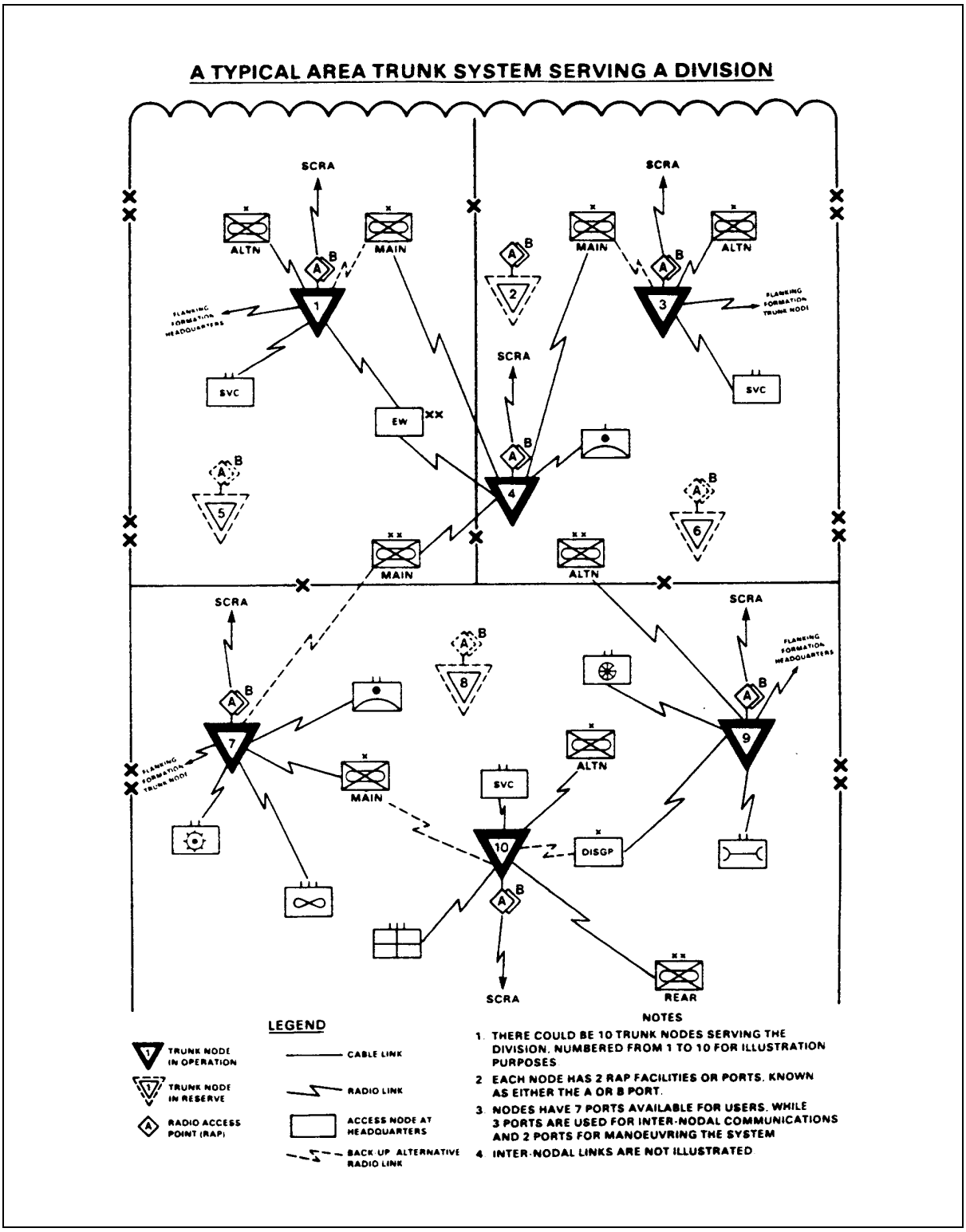

Figure B-1

ANNEX C

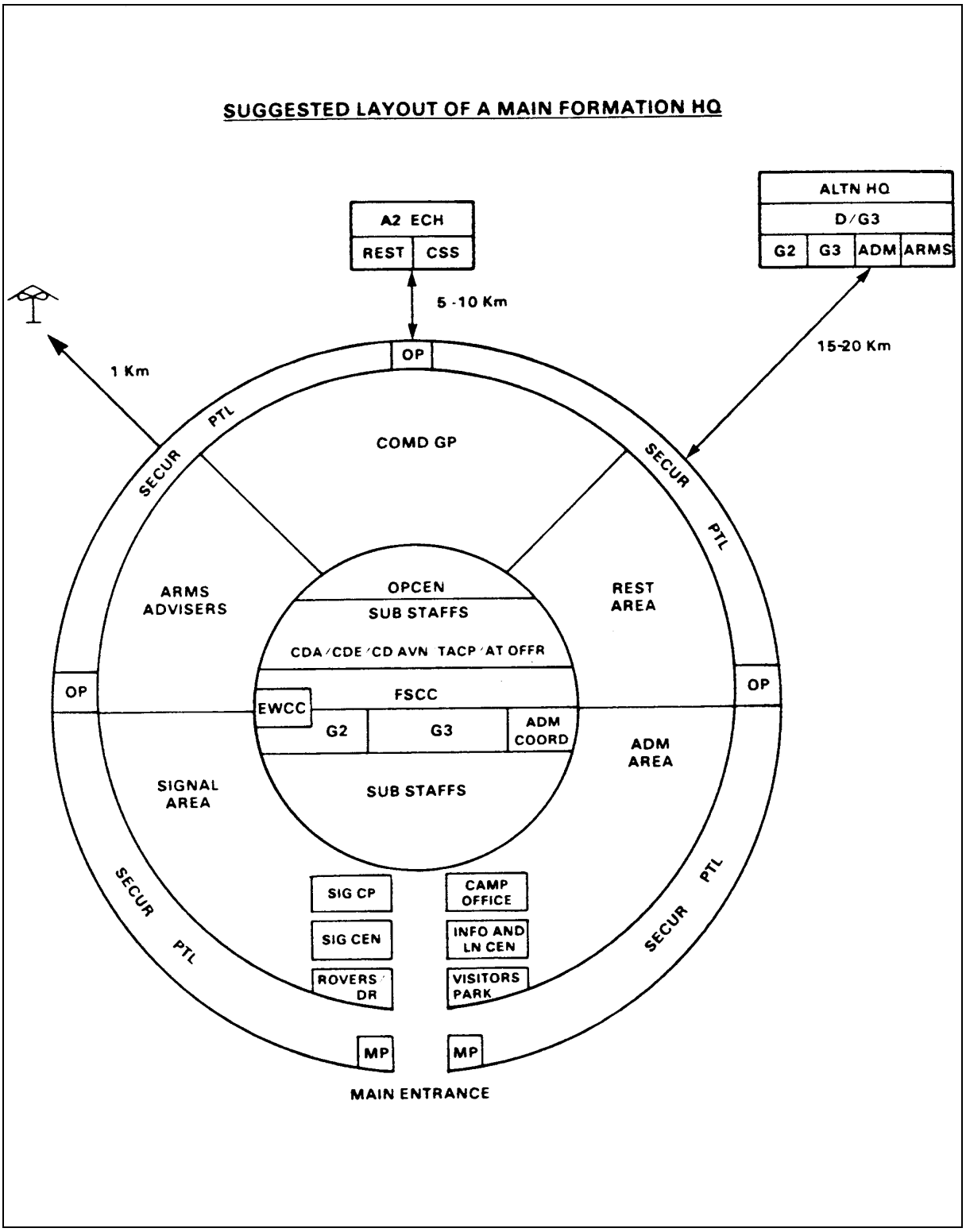

Figure C-1

ANNEX D

STANAG 2113 (Extract)

DESTRUCTION OF MILITARY TECHNICAL EQUIPMENT

AGREEMENT

1. The NATO Army Forces agree:

   a. that it is essential to destroy, to the maximum degree possible, military technical equipment abandoned in wartime operations, to prevent its eventual repair and use by the enemy; and

   b. to follow the principles and priorities set forth in this agreement in the destruction of their own equipment, when required.

PRINCIPLES AND PRIORITIES

2. **Detailed Methods**. Detailed methods of destroying individual items of equipment are to be included in the applicable technical publications, user handbooks, and drill manuals.

3. **Means of Destruction**. Nations are to provide for the means of destruction for their own equipment.

4. **Degree of Damage**

   a. **General**. Methods of destruction should achieve such damage to equipment and essential spare parts that it will not be possible to restore the equipment to a usable condition in the combat zone either by repair or cannibalization.

   b. **Classified Equipment**. Classified equipment must be destroyed in such degree as to prevent duplication by, or revealing means of operation or function, whenever possible, to the enemy.

   c. **Associated Classified Documents**. Any classified documents, notes, instructions, or other written material pertaining to function, operation, maintenance, or employment, including drawings or parts lists, must be destroyed in a manner to render them useless to the enemy.

5. **Priorities for Destruction**

   a. Priority must always be given to the destruction of classified equipment and associated documents.

b. When lack of time and/or stores prevents complete destruction of equipment, priority is to be given to the destruction of essential parts, and the same parts are to be destroyed on all like equipment.

c. A guide to priorities for destruction of parts for various groups of equipment is contained in Appendix 1 to this Annex.

6. **Equipment Installed in Vehicles**. Equipment installed in vehicles should be destroyed in accordance with the priorities for the equipment itself.

7. **Spare Parts**. The same priority, for destruction of components parts of a major item must be given to the destruction of similar components in spare parts storage areas.

8. **Cryptographic Equipment and Material**. The detailed destruction procedure to be followed in order to ensure the rapid and effective destruction of all types of cryptographic equipment and material is to be specified in instructions issued by the appropriate communication security authority.

9. **Authorization**. The authority for ordering the destruction of equipment is to be vested with the commander of the division or higher commanders, who may delegate authority to subordinate commanders when necessary. Standing orders should cover the destruction of isolated equipments which have to be abandoned on the battlefield.

10. **Reporting**. The reporting of the destruction of equipment is to be done through command channels.

APPENDIX 1, ANNEX D

PRIORITY OF DESTRUCTION BY TYPE EQUIPMENT

1.	Vehicles (including tanks and engineer equipment)	1	Carburetor/fuel pump/injector distributor.
		2	Engine block and cooling system.
		3	Tires/tracks and suspensions.
		4	Mechanical or hydraulic systems (where applicable).
		5	Differentials.
		6	Frames.
2.	Guns	1	Breech, breech mechanism, and spares.
		2	Recoil mechanism.
		3	Tube.
		4	Sighting and fire control (Priority 1 for Anti-aircraft guns).
		5	Carriage and tires.
3.	Small Arms	1	Breech mechanism.
		2	Barrel.
		3	Sighting equipment (including Infra-Red).
		4	Mounts.
4.	Optical Equipment	1	Optical parts.
		2	Mechanical components.
5.	Radio	1	Transmitter (oscillators and frequency generators) and IFF equipment.
		2	Receiver including IFF equipment.

		3	Remote control units or switchboards (exchanges) and operating terminals.
		4	Power supply and/or generator set.
		5	Antennas.
		6	Tuning heads.
6.	Radar and Other Electronic Equipment	1	Frequency determining components, records, operating instructions, which are subject to security regulations, and identification material (Identification Friend or Foe (IFF)).
		2	Antennas and associated components such as radiators, reflectors, and optics.
		3	Transmission lines and waveguides.
		4	Transmitter high voltage components.
		5	Control consoles, displays, plotting boards.
		6	Cable systems.
		7	Automatic devices.
		8	Other control panels and generators.
		9	Carriage and tires.
7.	Guided Missile Systems	1	Battery control centres.
		2	Missile guidance equipment (including homing systems).
		3	Launchers including control circuits.
		4	Missiles.
		5	Measuring and test equipment.
		6	Generators and cable systems.

8.	Aircraft and Surveillance Drones	1	Identification (IFF) equipment, other classified electronic equipment, publications and documents pertaining thereto, and other materiel as defined by the national government concerned.
		2	Installed armament (use sub-priorities for Group 2, Guns, or Group 3, Small Arms, as appropriate).
		3	Engine Assembly (priorities for destruction of magnetos, carburetors, compressors, turbines, and other engine sub-assemblies to be determined by national governments, depending on type of aircraft involved and time available for destruction).
		4	Airframe/control surfaces/undercarriage (Priorities for destruction of propellers, hub-rotor blades, gear boxes, drive shafts, transmissions, and other sub-assemblies (not already destroyed in priority 3) to be determined by national governments, depending on type of aircraft involved and time available for destruction).
		5	Instruments, radios, and electronic equipment (not included in priority 1).
		6	Electrical, fuel, and hydraulic systems.
9.	Rockets	1	Launcher.
		2	Rocket.
		3	Sights and fire control equipment.

ANNEX E

THE SIGNAL ESTIMATE OF THE SITUATION

PART 1

BACKGROUND

INTRODUCTION

1. All modern armies teach their decision makers a sound and systematic method of reasoning to resolve military problems. Within NATO, this process is called the "estimate of the situation" and is defined as: "a logical process of reasoning by which a commander considers all the circumstances affecting the military situation and arrives at a decision as to the course of action to be taken in order to accomplish his mission".

2. The form of the estimate has been developed so that it can be applied at all levels of command and to all types of operations. Thus at lower levels, although the reasoning process is the same, it will suffice to answer mentally a few simple questions (why? what? with what? against what? when? where? and how?). On the other hand at higher levels, analysis of the aim, factors and courses open will become more complex and extensive. This requires a formalized reasoning process as well as a division of effort among staff branches. Similarly although different types of operations will result in different deductions, the reasoning process will remain valid.

3. Estimates initiate the operational planning process. They are done either by commanders alone at lower levels or by commanders assisted by staff officers at higher levels. A commander's personal estimate could be done mentally or by jotting down informal personal notes. When staff input is required (normally at division and above levels) the staff team is headed and coordinated by the Chief of Staff. The latter will decide on the work to be divided among staff branches. In making his decision, he will consider the complexity of the situation and the time available. Thus the signal estimate is normally a subsidiary component of the tactical commander's estimate.

4. Depending on the situation and the level of command, signal estimates can be prepared and presented in both oral and written forms. The latter shall be the exception rather than the rule.

AIM

5. To explain the reasoning process underlying the signal estimate of the situation.

ANNEX E

PART 2

DISCUSSION

OVERALL CONCEPT

6. **Prerequisites**. A prerequisite to the successful completion of signal estimates of the situation is the availability of up-to-date and precise information on the superior tactical and signal commanders' concept of operations, the environment, the enemy, friendly forces, and time and space. This information can take various forms: SITREP, INTREP, maps, photos, etc, but must be as accurate and up-to-date as possible.

7. **Basic Principles**. The reasoning process is based on a progressive and logical approach allowing the complete and systematic analysis of all elements of the problem. The signal problem can be compared to a prism which one examines. Despite the fact that all facets are interrelated and reflect upon one another, you must carefully examine each facet to ensure you have not overlooked any flaw or hidden aspect before you can appreciate the value of the whole. The examination will result in the subjective (tactics are not a science but an art) but conscious and deliberate choice of a course of action. The reasoning process can be broken down into four steps:

a. the definition and selection of the aim - where both the superior commander's and the enemy's intentions are analysed and the aim selected;

b. the definition and analysis of the factors - where both friendly and enemy capabilities are analysed and assessed within the context of the situation;

c. the definition and analysis of courses open and the selection of the best course of action - where friendly courses of action are defined, analysed, compared and a selection of the best of own courses is made; and

d. the definition of the plan - where the selected course is translated into an outline plan.

DEFINITION AND SELECTION OF THE AIM (STEP 1)

8. For the purpose of an estimate, the word aim" has the same meaning as that given mission" in the army glossary.

9. The correct definition and selection of the aim is vital to the reasoning process. Whilst at lower levels of command, the aim is readily obvious in the superior commander's orders; at higher levels, the aim might not be so clear and a careful examination of the available information will be required before the definition and selection of the aim is possible.

10. Under these circumstances, the following sub-steps should be followed in sequence to ensure the full understanding of the framework within which the aim is to be achieved, and the identification of all assigned and implied tasks:

a. review the higher signal commander's analysis of enemy RECS and tactical intentions;

b. review the higher tactical and signal commanders' concept of operations, including all expressed political, operational and administrative limitations;

c. examine your own assigned and implied tasks; and

d. define your aim including the limitations as required.

11. In the course of the above analysis you may come across constraints placed on your action by the superior tactical and signal commanders; these are limitations beyond your power to alter. These must be clearly stated in your aim.

12. In some cases at higher levels of command, estimates are initiated as part of the contingency planning process; in such cases, the selection of the aim must follow the same logical sequence as explained at paragraph 10 but must be based on an assumption of enemy and superior commanders' intentions and of your own tasks.

13. The aim of an estimate is expressed in the infinitive. The verb used must be an action verb and must be qualified only by identified and imposed limitations.

14. **Example**. Your tactical commander tells you: "I want to capture objective 4 by 1000 hrs tomorrow. In view of the air situation I might consider doing a night attack. I want you to propose a signal plan to support this operation". You have also been advised by the superior signal officer that radio silence will be in effect at that time and that an additional line troop will be assigned to you. The facts that the objective must be captured by 1000 hrs tomorrow, and that radio silence will be in effect are limitations but the air situation and the line troop are factors which you will consider in your estimate. The aim should therefore be expressed as: "Aim. To provide signal support for the attack of obj 4 by 1000 hrs tomorrow under condition of radio silence."

DEFINITION AND ANALYSIS OF THE FACTORS (STEP 2)

15. **General**. From the consideration of Step 1, you should be able to deduce the factors to be considered and the order in which they will be analysed. You must, during Step 2, analyse all the factors which will affect the execution of your aim, deduce the net capabilities of both sides and thus prepare yourself for the definition of practical courses open. Since a factor is defined as "a circumstance, fact or influence contributing to a result", it will be obvious that this could lead to the separate analysis of a long list of factors (enemy and own troops capabilities, ground, time and space, surprise, logistics, air situation morale, population, security, meteorology, etc.). It is suggested, however, that all these factors and more can be analysed more easily when regrouped

logically. The following suggested approach should be adequate for most types of operations if it is accepted that the list of factors, the sequence of analysis, the nature and scope of deductions and the weighting of factors may vary according to the situation and the type of operation being planned.

16. **Concept**. The key to the proper deduction of courses open to both sides is the analysis and comparison of their combat power. In a given situation, the net combat power of each opponent is a function of three major factors: the gross combat power inherent in a given force (personnel/organization/weapon/equipment), the environment to which this combat power will be subjected, and the time frame during which it will be possible to exert it. The environment is the most pervasive element affecting the combat power of both opponents on the battlefield. Therefore by starting the analysis with the environment and by studying the constraints it places over the opposing forces it will be possible to draw time and space deductions and to deduce the net combat power available to both sides. Then make a comparison of opposing forces, by completing the assessment of tasks as a preliminary step to the formulation of courses open.

17. **Sequence**. The sequence of analysis should therefore be as follows:

a. the environment, subdivided in the following main headings: ground general, approaches, key terrain, obstacles, populated areas and meteorology;

b. enemy or own forces capability depending on which side should be examined first; normally the side with the initiative should be considered first;

c. time and space, where the analysis of both forces capability is completed; and

d. assessment of tasks, two levels down the chain of command, where you compare opposing forces capabilities and deduce those tasks which you will have to do to achieve your aim and the forces required to carry them out.

18. **Analysing the Factors**. Most officers find it difficult to appreciate the full significance of their aim. Therefore in order to draw appropriate deductions from the analysis of the factors, they usually have to resort to an intermediate step and break down the aim into the major tasks which are required to carry it out. They then find it easier to draw concrete deductions about these tasks. Appendix 1 provides an example of this breakdown. This example is not exhaustive but illustrates the technique suggested. Once you have listed the relevant facts about each factor in the left-hand column, you must ask yourself: "How does this affect my aim? How does this affect each task (eg, CNR, trunk, SDS, movement, protection, administration, logistics)? So what?" You should thus deduce facts or draw conclusions which are relevant to the accomplishment of tasks inherent to your aim, and which can contribute to narrowing down and defining the courses open. Do not remain within the bounds of general principles but ensure your deductions lead to concrete actions and decisions. Remember that:

a. the reasoning process is cumulative. The analysis of one factor will not yield all the required answers. Keep an open mind; do not be upset by contradiction

between deductions. Keep your options open; at this stage, you cannot state "I must" but "I could" or "I should";

b. although each factor is weighed on its own merits, do not ignore previous deductions; for example, if a communication site is physically advantageous but tactically unsound because of the enemy disposition, do not waste time working out the time required to deploy to it under time and space; and

c. a factor or deduction which is irrelevant must be excluded.

19. **The Environment (Where?)**

a. **General**. An analysis of the environment (ground, populated areas and meteorology) must be made as a first step in the analysis of the combat power of both sides. A commander who would know the environment extremely well could skip this factor and move on immediately to the next factor; however in the case of a staff officer, even if he knew the environment very well, he would still present his analysis to show the basis of his assessment.

b. **The Ground**. Appendix 1 describes the suggested breakdown and sequence of analysis of the ground. To save the reader the trouble to decipher grid references, attach an overlay or a map on which all significant features are identified and given a figure or letter code: key terrain (defensive position, HQ sites, RRB sites, objectives, vital ground) should be numbered and approaches should be indicated by an arrow and lettered.

c. **Populated Areas**. The size and behaviour of the population including characteristics of built-up areas must be carefully assessed as to their effect on the achievement of the aim, when fighting and signalling in or around populated areas, is contemplated. When this factor has a very limited application, it might be included within ground.

d. **Meteorology**. See Appendix 1. The influence of weather on ground and combat capabilities of both opponents must be assessed. Changes in weather or light conditions can result in different combat capabilities on one and the same terrain. This is critical for signal, air and NBCW operations.

20. **Forces Capability**

a. **General**. In order to arrive at a reasonable deduction of courses open and a logical decision on your best course of action, you must have a thorough understanding of the capability and limitations of both the enemy facing you and the forces at your command. To achieve this, it will not suffice to do a mathematical tabulation of signal resources (communication and EW) available to each side; you will have to examine each opponent's forces in a systematic manner. You will have to take into consideration influences such as morale, the environment and time before setting

down your conclusions. In general you should examine the forces of each side in the following sequence.

(1) **Decide Which Side Must be Examined First**. Normally this would be the side with the initiative (the attacker). In any case, follow the sequence used by the commander.

(2) **Level of Command**. Adopt the level of command used by the tactical commander to do his examination and which will be used to express units of strength; for example, if the commander has deduced that your opposing level in a defensive operation is a Combined Arms Army, he would define capabilities in multiples of MRR/TR (two levels down the chain of command) and you would define enemy signal capabilities in equivalent level signal units.

(3) **Disposition**. Examine the general disposition of your troops or that of the enemy. Pay particular attention to major fire, command and control and RECS units.

(4) **Order of Battle**. Examine the electronic order of battle (identity, type, armament, strength, in position, in reserve, reinforcement) in the following sequence:

(a) **Security forces (reconnaissance, surveillance, protection)**. Stress electronic reconnaissance units. Capabilities of tactical units two levels of command down are examined.

(b) **Manoeuvre units**. Use data from G3. Examine influence on the signal plan:

i. armoured units,

ii. anti-armour units,

iii. infantry units, and

iv. aviation units.

(c) **Fire support units**. Use data from G3. Examine influence on the signal plan:

i. artillery units,

ii. air defence units, and

iii. air.

(d) **Mobility/counter mobility units**. Use data from G3.

(e) **Command and control units (HQ, signal, EW)**. Carry out a detailed analysis.

(f) **Administrative and logistics units (including medical)**. Use data from G4.

(5) **NBCW**. Examine capabilities and activities. Use data from G2.

(6) **Doctrine**. Examine effects on your operation or divergence from accepted doctrine.

(7) **Activities**. Examine recent, present and foreseeable activities.

(8) **Morale**. This will have an effect on net capability and on the psychological operations plan.

(9) **Leadership**. The quality of leadership is an important part of combat power.

(10) **Weaknesses/Vulnerabilities**. Those which can be readily exploited by an opponent.

b. **Enemy Forces Capability (Against What?)**. Do not look at the enemy in an abstract manner. Once you have examined his capabilities as per paragraph 20a, relate it to the ground and take into consideration the time and space factors and draw conclusions as to the net capability of the enemy in this situation. It is too early to examine courses open but having examined the enemy overall intentions in Step 1 and his capability in Step 2 it is possible to deduce his net combat power and his ability to affect your aim or specific combat tasks implied in your aim. See Appendix 1.

c. **Own Force Capability (With What?)**. This factor should be developed as explained at paragraph 20a and b. Compare your forces to that of the enemy only if you can draw a worthwhile deduction relative to your aim or your tasks. Only compare if it makes sense to do so. For example, there is no point in comparing your EW against his RECS but it might be worthwhile looking at his RECS capability and drawing conclusions about your capability to provide communication for friendly troops or your commander's capability to neutralize his RECS capability by fire. Remember that the aim of this factor is to define what each component of your force is capable of doing towards the achievement of the aim.

21. **Time and Space (When?)**. The characteristics of the ground and the possible time limitations or considerations affecting your aim will have a definite influence on the capabilities of opposing forces. These effects must be defined prior to assessing tasks.

22. **Assessment of Tasks (What?)**

a. This sub-step has caused both controversy and confusion in recent years. In effect, it resembles the comparison of opposing forces' capabilities done in certain armies; except that in this case, it is oriented towards the combat tasks required to be performed for the accomplishment of your aim. Your purpose in this step is to consolidate all the deductions you have made from the study of the other factors and to draw appropriate conclusions as to the nature and scope of tasks which may have to be accomplished to achieve your aim and to establish the nature and size of the forces which may have to be affected to each task. These possible combat tasks are normally expressed by type and quantified in numbers of basic signal elements (dets, RRB, nodes, etc) available two levels down the chain of command. Do not attempt to task specific units or sub-units at this stage.

b. Although signal plans must take cognizance of both enemy and friendly intentions, they should be based mostly on capabilities. Since intentions are difficult to define and volatile, a plan based mostly on intentions may or may not meet all possible threats but a plan based on defined capabilities should reasonably be expected to counter all enemy intentions since the latter are of necessity based on capabilities.

c. This assessment of tasks should be carried out in the following sequence:

(1) decide on the list of combat tasks which you will consider, these should be considered in some sort of logical, geographical and chronological framework and be derived from your aim;

(2) for each task, determine the forces which the enemy can bring to bear and deduce the type and strength of forces which you will have to employ to achieve your aim;

(3) identify possible surplus or deficiencies;

(4) identify tasking priorities; and

(5) identify problem areas/phasing requirements/courses not available.

d. Once this is done, you will have confirmed the number and scope of most major tasks, identified those which are mandatory or optional, simultaneous or consecutive; this in turn should prevent you from formulating obviously impossible courses, lead to the confirmation of certain weaknesses and strengths

and allow you to progress smoothly to Step 3: the definition and analysis of courses open. Appendix 1 gives further details on this subject.

DEFINITION AND ANALYSIS OF COURSES OPEN (STEP 3) (HOW?)

23. Sequence of Analysis

a. In Step 1, you analysed both enemy and own intentions and in Step 2 enemy and own capabilities culminating with a definition of tasks; you should now be in a position to define and analyse own courses open.

b. To allow a tidy analysis and discussion, defined courses should not be so narrow as to cause an unmanageable number of options to be considered or so broad as to have no distinguishable features worthy of analysis.

24. Own Courses

a. By this stage, all deductions and conclusions are complete and you are in a position to define your courses open. List the possible and reasonable courses of action open to you for the accomplishment of your aim. If you conclude that only one course is open to you, you should check the logical process of your previous steps to ensure you were not too categorical in your dismissal of an option. Courses open are defined in terms of why (purpose of the action), what (by line, SDS and CNR), where (areas of deployment, relay sites, routes), when (timings) and how (order of importance of systems, timings, manoeuvre). Finally, ensure your courses open do not project too far beyond the immediate aim which has been assigned to you and enter the realm of pure conjecture.

b. Once defined, own courses should be analysed in the sequence which best responds to the threat posed by the enemy. Your own courses must be checked against the deductions and conclusions drawn earlier in the estimate to ensure they do not contradict any, and against the principles of war/operations which the commander has decided should be bench marks for his operation. From these considerations you should deduce advantages/disadvantages to own troops relative to the accomplishment of your aim, and assess the degree of risk involved.

c. In deciding on advantages/disadvantages for each course, you should pose the following questions:

(1) Do I exploit all the opportunities of the situation and weaknesses of the enemy?

(2) Does my signal plan conform to and support the commander's concept of operation?

(3) Do I have the forces capable of accomplishing the aim in this manner?

(4) What are the undesirable features of this course? Can I accept them?

(5) Can I accept the losses to be expected?

d. The comparison of advantages and disadvantages for each course should enable you to deduce the best of own courses. This comparison allows you to check whether your own courses which are based primarily on enemy capabilities can stand the test of all foreseeable enemy action; it should also bring out clearly the advantages/risks of each of your own courses in the face of each enemy action and prepare you to face up to the uncertainties of war in the upcoming battle.

e. At the end of the comparison it should be possible to:

(1) assess possible enemy reactions during each phase of a course,

(2) assess flexibility of own courses in the face of enemy reactions,

(3) identify critical areas and possible changes either in the planning or execution phases, and

(4) confirm the best course of action open to own troops.

25. **Selection of the Best Course of Action**

a. This is a simple statement of your choice and a summary of the main reasons which led to it. Your selected course of action must:

(1) follow logically from the estimate,

(2) accomplish the aim within imposed limitations,

(3) be able to face up to foreseeable enemy reactions, and

(4) provide the least or an accepted degree of risk.

b. Of course, if this part is prepared by the staff for the commander's approval, the choice is a recommendation, not a decision.

PLAN (STEP 4)

26. The signal estimate will be complete when you have translated the course of action into an outline plan, sufficiently detailed for a staff officer to write a C-E operation order. The following questions must be answered: why (the overall purpose of the action), what (the mission), how (the concept of operation), by whom/what (specific tasks and groupings), where (areas of operation), when (time constraints).

27. A commander can assign specific units to tasks but a staff officer would be content to recommend types of units.

28. A marked map sketch or overlay may prove quite useful and time saving to accomplish this task.

29. After you finish the signal estimate, you should make a point of reviewing critically the whole estimate to check against errors/omissions.

LAYOUT AND PRESENTATION

30. The layout at Appendix 1 should be suitable for most estimates. The only variation should be in the selection and sequence of the factors as discussed above. Estimates are considered operational writing and the relevant rules (maximum use of abbreviations, etc) must be followed.

31. Frequently, during exercises or operations, you will be required to present estimates orally. Rough notes only need be prepared but the sequence and content should be as explained above. Logic, precision of expression, proper emphasis and correction are of capital importance in oral presentations because the audience cannot read back for clarification.

ANNEX E

PART 3

CONCLUSIONS

32. **Conclusions**

a. This Annex adapts the former "appreciation technique" to the NATO terminology and the Canadian Staff planning process. A detailed study of this Annex and the suggested format at Appendix 1 should enable officers to be comfortable after only a few case studies.

b. This suggested approach is meant to be a learning tool. It is not expected that, in operational training or in operations, commanders and staff officers will follow it slavishly; but, having assimilated the fundamentals of the reasoning process and acquired the basic logical reflexes, they should be able to adapt as required to specific military situations.

APPENDIX 1, ANNEX E

FORMAT FOR A SIGNAL ESTIMATE

(Secur cl)

Copy No_____of_____[1]

SIGNAL
ESTIMATE
BY

LCol T. Rhéault, CD Sigs, 5 CDN Mech Div[2]

At Toronto at 1559 hrs
On 25 Mar 84

Ref: A. A501 CANADA, Sheet 31 (LAKE SIMCOE), Edition 4 ASE, 1:50,000.

Time: Z Romeo

STEPS OF THE ESTIMATE	DEDUCTIONS/CONCLUSIONS
1. **Definition and selection of the aim:**	
a. Review higher sig comd's analysis of en RECS and tac intentions.[3]	a. En RECS and tac objs in your area of responsibility.
b. Review higher comd's (tac and sig) concept of ops (why?).[4]	b. Higher comd's instructions
c. Examine current and planned assigned and implied sig tasks (what?).	c. Own aim and limitations.
2. **Definition and analysis of the factors:** [5]	2.
a. **Definition of the factors.**	a. List factors in sequence of considerations.[6]
b. **The environment (where?):** [7]	b. Sig characteristics of the grd:
(1) **Grd gen:** [8]	(1) advantages/disadvantages of CNR, trunk, line, SDS, ADS.
(a) features,	(2) mov (speed, timings, routes).
(b) hydrography,	(3) manoeuvre (on-off rds, cam, obsn).
(c) vegetation,	(4) disp, loc of HQ.
(d) comm (rds, etc.),	(5) use of indigenous sig facilities.
(e) infrastructure, and	(6) effects on sig log to incl resup of dets and atts.
(f) soil conditions.	

STEPS OF THE ESTIMATE	DEDUCTIONS/CONCLUSIONS
(2) **Axis of manoeuvre:** [9] (a) described from LEFT to RIGHT as facing the en and in the direction of mov. (b) Each axis is assigned a letter starting with A. (c) These axis correspond to the GS approaches and/or the deployment areas of subordinate fmns.	c. Sig characteristics of the axis: (1) key terrain for RRBs, repeaters, HQ and trunk node sites. (2) obs to sig mov/channelling (3) advantages/disadvantages to lateral comm/mov. (4) effects on propagation (5) screening from en RECS. (6) time/space. (7) mov of HQ. (8) loc of res. (9) site clr (G3) reqrs. (10) civ facilities aval. (11) co-ord reqrs with subordinate sig elms.
(3) **Key terrain**. Used in a generic sense, it incl vital grd, grd dominating and axis of manoeuvre, grd of sig tac importance.	d. Sig characteristics of key terrain (1) suitability for deployment of HQ, RRBs, repeaters and nodes, (2) grd cir, (3) vulnerability to en RECS and/or physical attack, (4) accessibility, (5) timings and scheduling, and (6) pri for deployment/sequencing.
(4) **Obs**	e. Sig characteristics of obs as they affect: (1) propagation (need for RRBs), (2) mov (channelling), (3) deployment of res, (4) timings,

STEPS OF THE ESTIMATE	DEDUCTIONS/CONCLUSIONS
	(5) log sp, (6) line and SDS routes, (7) con measures, and (8) harbours.
(5) **Populated areas:** (a) density, (b) mov, and (c) attitude.	f. effects on: (1) sig manoeuvre, (2) EW, RECS, (3) comm, (4) time and space, (5) ability to use civ sig facilities, and (6) log.
(6) **Met:** (a) weather (elements), (b) temperature, and (c) light data (day/ni).	g. effects on: (1) pers and eqpt, (2) propagation, (3) mov (time/space), and (4) needs for close-in protection.
c. **En forces capabilities (against what?)**[10] (1) elec disposn (RECS and C^2 units, (2) elec orbat (identity), (3) str (in posn, in echs, replacements, log), (4) NBCW, (5) activities (recent, present, forecasted), (6) morale, (7) doctrine, (8) leadership, and (9) air.	h. en ability to DF, intercept jam, infiltrate, attack; j. need for: (1) screening in deployment, (2) emission control/ECCM measures, (3) ECM measures and pri, (4) cam and concealment, (5) day/ni mov of elms, (6) mov restriction (especially in the fwd area of the FEBA), and (7) secur of isolated dets, nodes, HQs, etc; (8) sigsec; k. advantages and disadvantages of each friendly C^2 means; m. en vulnerabilities which might be exploited; n. elec EEI/OIRs;

STEPS OF THE ESTIMATE	DEDUCTIONS/CONCLUSIONS
d. **Own forces capabilities (with what?)** [11]	p.
(1) disposn (comm and EW),	(1) own resources committed and aval incl atts and dets;
(2) orbat (comm and EW),	(2) ability to use/deploy own C^2 and EW systems;
(3) str (in posn, in res, replacements),	(3) freqs committed and aval;
(4) NBCW,	(4) res;
(5) adm and log,	(5) sigsec;
(6) morale,	(6) vulnerabilities; and
(7) readiness/aval, and	(7) D&S resources.
(8) air.	
e. **Time and space (when?)**	q.
(1) amount of day/moon lt,	(1) planning/preparation:
(2) mov conditions,	(a) time aval, and
(3) deployment distances, and	(b) time required;
(4) imposed timings/restrictions in time such as time for opening of nets.	(2) amount of prep possible;
(5) phasing of the tac manoeuvre.	(3) degree of prep for altn plans;
	(4) loc of res;
	(5) mov timings for various elms; and
	(6) suitability of various systems.
f. **Assessment of tasks (What?)** [12]	r.
(1) **Choice of tasks.** [13]	(1) Decide on the list of tasks to be considered in order of pri.
(2) **CNR - VHF (for each net):**	(2) For each task, considering the deductions reached under previous factors (en, environment, etc.), deduce the type and number of sig elms, which will be needed to achieve your aim.
(a) aval (freq, dets, RRB), and	
(b) reqrs (freq, dets, RRB),	(3) Compare forces aval with forces required.
(3) **CNR - HF (for each net):**	(4) Once the task analysis has been completed, you should be able to identity:

STEPS OF THE ESTIMATE	DEDUCTIONS/CONCLUSIONS
(a) aval (freq, dets), and (b) reqrs (freq, dets, propagation, antennas), (4) **CNR - RT. As above.** (5) **CNR - A/G/A. As above.** (6) **Truck system:** (a) **line:** (civ facilities, dets and line in kms). i. aval, and ii. reqrs, (b) **Trunk nodes (freqs, ports, SCRA and repeaters):** i. aval, and ii. reqrs. (c) **Access nodes (aval/required:** i. cct switch, ii. msg switch, iii. locals, and iv. trunk lines. (7) **Hand carriage:** (a) **SDS:** i. dets aval, ii. dets required, and iii. routes and timings. (b) **ADS:** i. aval, ii. ac reqrs, and iii. routes and timings.	(a) possible surplus or deficiencies, (b) the scope and number of major tasks, (c) possible phasing reqrs, (d) significant strs and weaknesses of the en and of own forces, and (e) basic types of manoeuvre open to you.
3. **Analysis of courses open (How?).** a. **Definition of courses.**	a. List only practical and feasible courses which stem from above analysis. b. Advantages and disadvantages to own tps deduced from the analysis of the factors above and the accomplishment of the aim:

b. **Course 1**. Description, i.e. "Provide comm using SDS as the pri means and trunk line as a secondary means"

c. **Course 2.** Description, i.e. "Provide comm using CNR as the pri means and area trunk system as a secondary means"

d. **Course 3**. Description

e. **Comparison of Courses.**

c. Compare advantages/disadvantages of each course to:

(1) assess flexibility of each course vis a vis possible en actions and the development of your own comd's manoeuvre.

(2) identify critical areas and possible adjustment in planning or exec phase.

f. **Decision/Recommendation.** [14] Describe briefly the course chosen incl possible adjustments made as a result of comparison.

d. Conclude as to the best course of action stating reasons for the choice. The chosen course must:

(1) fol logically from the sig est,

(2) accomplish the aim within limitations imposed,

(3) be able to meet the challenge of the en reactions, and

(4) best sp the friendly tac manoeuvre at min or accepted degree of risk.

4. **Outline plan.**

a. This is not the C-E OpO but it must incl sufficient details to allow a staff offr to write complete orders.

a. Msn.

c. Rad.

d. Trunk.

e. Hand carriage.

f. Sig sec/EW.

g. Comm res.

h. Physical protection.

j. Co-ord instrs.

k. Svc sp.

m. Comd and sig.

b. Assign/recommend groupings and tasks.[15]

c. Pri and phasing if required.

Signature [16]

1 Required only if distribution is desired.

2 The rank, name and appointment of the author except in the case of a staff officer writing an estimate along specific guidelines given by his commander when the heading would read: "Estimate from the point of view of" followed by the particulars of the commander.

3 When doing contingency planning, assume 1a, 1b, and 1c.

4 Includes political, operational and administrative limitations.

5 Factors suggested should be adequate for most operations given that deductions will vary in nature and scope with the type of operation and that weighing of factors among themselves will also vary.

6 The suggested sequence of factor analysis may be varied if the situation demands.

7 At lower levels, this grouping title could be dropped.

Ground is to be examined from both the friendly and enemy signal commander's point of view.

9 Axis must be examined for ability to support the signal manoeuvre, identify key terrain and obstacles on each axis and consider the capability of the enemy to conduct RECS on each axis.

10 Establish the level of command to be examined and express capabilities two (2) levels down the chain of command.

11 Express capabilities in terms of basic elements, ie, dets, nodes, units.

12 Assessment conducted on the basis of capabilities/possibilities only, as a preliminary step, prior to the formulation of courses.

13 Tasks are expressed in terms of basic system elements, ie, dets, nodes, etc.

14 A Commander decides and a staff officer recommends.

15 A commander assigns and a staff officer recommends.

16 If the author is not the officer identified in the heading, he signs below the outline plan showing his rank, name and appointment.

ANNEX F

FORMAT - COMMUNICATIONS - ELECTRONICS OPERATIONS ORDER

(Secur cl)

Copy No_____of_____

Main HQ 1 Div
KEFLAVIK 6353
(DTG by hand) Jan 94
SIG 15

C-E OpO

Refs: A. Maps
B. Div OpO 1 23 Oct 93

Time Z: ZULU

1. **Situation** (Note that para headings are not abbreviated)

   a. En Forces

   b. Friendly Forces

   c. Atts and Dets.

2. **Mission**

3. **Execution**

   a. **Gen Outline**. This is where the concept of op for the sig manoeuvre is given.

   b. **Unit/Sub-Unit**

      (1) **Grouping**. Subordinate sig units are listed in order of size and seniority. Only those tasks which are not SOPs need be given.

      (2) **Tasks**. Where conflicts in employment of sig resources may arise, pri and deadlines must be specified.

   c. **Unit/Sub-Unit**

   d. **Unit/Sub-Unit**

e. **Co-ord Instrs**. Tech info required for the subordinate comd's understanding of the comm plan. In most cases, ref to a supporting CEOI shall be adequate; only exceptions and complementary info are required.

(1) **Timings**

(2) **Orders and Instrs. CEOIs, CESIs, etc.**

(3) **Rad**

(a) Nets

(b) Data

(4) **Trunk System**

(a) Subscriber access (units, not individuals)

(b) Trunk node alloc

(c) Data

(d) SCRA

(e) Directory

(f) RR

(g) Trunk lines

(5) **Line**

(a) Pri of Work

(b) Alloc of Tasks

(6) **SDS**

(a) Routes

(b) Schedules

(c) SDR

(7) **Freqs**. CEOIs, TGP list

(8) **Sigsec**:

(a) Codes and Crypto keys

(b) Changeover. CESIs.

(c) Compromise

(9) **Elec Silence**

(10) **Rad Silence**

(11) **Time Standard**

4. **Service Support**

a. **Gen Outline**. Adm O, Locs.

b. **Mat and Svcs**

(1) Ammo

(2) POL

(3) Rat

(4) Water

(5) Tpt

(6) Eqpt Replacement

(7) Engr Sp

(8) Sup

(9) Sal

(10) Repair. Policies and pri.

(11) Rec

(12) Backloading

(13) Misc. Local purchase, Post, CANEX

c. **Mod/Evac and Hospitalization**

(1) Locs

(2) Evac

d. **Pers**

(1) MP

(2) PW

(3) Rfts

(4) Chaps

(5) Fin

(6) Morale, Welfare, Pers Svcs

(7) Reports/returns

(8) Discipline

e. **Misc**

(1) RAS. Def and protection.

(2) CIMIC

5. **Command and Signal**

a. **Loc**

b. **Codewords**. Nicknames, passwords.

Ack Instrs: Ack

Surname
Rank

Authentication

Anxs

Distr

APPENDIX 1 ANNEX F

EXAMPLE OF A COMMUNICATIONS - ELECTRONICS ANNEX

(Secur cl)

Copy No 1 of 34

Anx H
TO 5 Div OpO 3
Dated 24 Oct 82

COMMUNICATIONS - ELECTRONICS

Refs: A. M726 GREAT BRITAIN, Sheet 185 (WINCHESTER AND BASINGSTOKE), Edition 2 GSGS, 1:50 000
B. I Corps C-E Instr 3 24 Oct 82
C. 5 Div OpO 3 24 Oct 82

Time Z: ZULU

1. **Situation**

a. **En Forces**

(1) See refs B and C.

(2) En is capable of disrupting up to 50% of friendly comd and con links.

(3) Hel force threat to the rear area.

b. **Friendly Forces**

(1) 5 Div HQ and Sig Regt must be ready to interface with US comm system on the RIGHT.

(2) Corps Comd has ordered strict emission control until contact except for AD rdr and EW comd links.

c. **Atts and Dets**

(1) Under comd forthwith — one hy constr tp 1 Line Constr Sqn
one lt constr tp 1 Line Constr Sqn

2. **Mission**. To provide C-E sp to 5 Div.

3. **Execution**

a. **Gen Outline**. The depl shall be done under elec silence; max use is to be made of civ comm facilities, mil lines and SDS.Once in the def posn, only AD rdr and EW comd links shall be allowed to op until contact is made. Once contact is made, the covering force shall be allowed to break elec silence but Div HQ will decide when to lift it. Sequence for lifting will be: covering force, div area systems, fwd bdes, depth bdes.

b. **5 Div HQ and Sig Regt**

(1) **Gp**

Under comd forthwith	one hy constr tp (-), 1 Line Constr Sqn one lt Constr tp (-), 1 Line Constr Sqn

(2) **Tasks**. To provide C-E sp to 5 Div tps IAW fol pris:

(a) To estb TC comm for mov to def posn (line and SDS only).

(b) To estb line comm network to subordinate fmns HQ's by first lt 25 Oct 82.

(c) To rfc div covering force line laying capability to ensure lines laid to battle gp HQ and fire units by first lt 25 Oct 82.

(d) To depl div area comm system in def area by first lt 25 Oct 82. To remain on standby until elec silence lifted.

(e) To provide In det to RIGHT (US) div HQ.

(f) Ln with PO within bdrys.

(g) To provide EW sp as ordered at Anx E of ref C.

c. **51 CMB HQ and Sig Sqn**

(1) **Gp**. No change.

(2) **Tasks**. To provide C-E sp to 51 CMB IAW fol pris:

(a) To estb TC comm within 51 CMB conc and fwd depl areas (line and SDS only).

(b) To estb line and SDS comm in fwd depl area down to battle gp and fire unit levels ASAP.

(c) To maint listening watch on CNR nets until elec silence lifted.

(d) To be ready to join div area comm systems as soon as elec silence is lifted.

d. **QG ET 52 BMC**

(1) **Gp**. No change.

(2) **Tasks**. To provide C-E sp to 52 BMC IAW fol pris:

(a) To estb TC comm within 52 BMC conc and fwd depl areas (line and SDS only).

(b) To estb line and SDS comm in fwd depl area down to battle gp and fire unit levels ASAP.

(c) To estb ln with US fmn on your RIGHT.

(d) To maint listening watch on CNR nets until elec silence lifted.

(e) To be ready to join div area comm systems as soon as elec silence is lifted.

e. **1 ACBG HQ and Sig Sqn**

(1) **Gp**. No change.

(2) **Tasks**. To provide C-E sp to 1 ACBG IAW fol pris:

(a) To estb TC comms within 1 ACBG conc and covering force deployment area (line and SDS only).

(b) To estb line and SDS comm in covering force area down to battle gps and fire unit levels ASAP.

(c) To estb In with US fmn on your RIGHT (in covering force role).

(d) To maint listening watch on CNR nets until contact is made.

(e) To be ready to join div area comm systems as soon as elec silence is lifted.

(f) Ln with 51 CMB and 52 BMC for passage of line comm.

(g) To estb lines down to battle gps and fire units in depth posns.

f. **53 CMB HQ and Sig Sqn**

(1) **Gp**. No change.

(2) **Tasks**. TO provide C-E sp to 53 CMB IAW fol pris:

(a) To estb TC comm within 53 CMB conc and fwd depl areas (line and SDS only).

(b) To estb line and SDS comm in fwd depl area down to battle gps and fire unit levels ASAP.

(c) To estb ln with US fmn on your RIGHT.

(d) To maint listening watch on CNR nets until elec silence lifted.

(e) To be ready to join div area comm systems ASAP after elec silence is lifted.

g. **5 DISGP HQ and Sig Sqn**

(1) **Gp**. No change.

(2) **Tasks**. In order of pri:

(a) To estb line comm between HQ and functional unit HQs.

(b) to maint listening watch on CNR nets until elec silence lifted.

h. **Div Arty HQ and Sig Sqn**

(1) **Gp**

Under comd forthwith	three dets, lt constr tp, Line Constr Sqn

(2) **Tasks**. In order of pri:

(a) To estb AD surv rdr ASAP.

(b) To estb line comm between rdr and AD fire con unit.

(c) To estb rad comm for AD units.

(d) To estb line comm between HQ and fire units remaining under direct con.

j. **Div Tac Hall WG HQ and Sig Sqn**

(1) **Gp**. No change.

(2) **Tasks**. In order of pri:

(a) To estb line comm between hel landing areas and Wg HQ in depl areas.

(b) To maint listening watch on CNR nets until elec silence lifted.

(c) To be ready to join div area comm system ASAP after elec silence is lifted.

k. **Co-ord Instrs**

(1) **Timings**

(a) All TC and conc area comm must be complete by 242000 hrs Oct.

(b) All covering force line comm ordered by this HQ must be completed by first lt 25 Oct.

(c) Remainder of line comm must be complete by last lt 26 Oct except for 1 ACBG's depth posn comm.

(d) Elec silence is imposed as of 241800 hrs Oct.

(2) **Orders and Instrs**. CEOIs 3/82 (War edition) in force as of 241800 hrs Oct.

(3) **Rad**

(a) **Nets**. As per SOPs. Copies of the latter to be given to 1 ACBG units.

(b) **Data**. CEOIs 3/82. g Sqn

(4) **Trunk System**

(a) CD Sigs to issue relevant msn orders for area system engineering.

(b) All RR shots to be proven then closed down.

(c) **Data**. CEOIs 3/82.

(d) **Directory**. To be issued in main def area.

(5) **Line**. Pri of work (in all cases preference shall be given to PO lines then to mil lines).

(a) Conc area comm.

(b) TC comm.

(c) Covering force comm and div level comm.

(d) Main def posns bdes and div tps comm.

(6) **Div Sigcen**. Opens in new loc by 250500 hrs Oct.

(7) **SIGSEC**

(a) All PO lines to be covered by crypto down to battle gp level or equivalent.

(b) Codes and Crypto keys. CEOIs 3/82.

(c) Changeover as per CESIs.

(d) Compromise editions. CEOIs 4/82.

(8) **Elec Silence**. In effect from 241800 hrs Oct except for AD rdrs and EW comd links until lifted by this HQ. To be lifted selectively from front to back.

(9) **Rad Silence**. Subordinate fmn comds may choose to remain on rad silence after elec silence is lifted for their fmn.

4. **Service Support**

a. See Adm 0 3/82.

b. **Elec Repairs Pri**

(1) Crypto eqpt to cover PO lines.

(2) Trunk system eqpt.

(3) CNR eqpt.

5. **Command and Signal**

a. **Loc**. HQ 5 Div remains present loc until 250500 hrs Oct when it reopens at NORTH WALTHAM 5646.

b. **Codewords**. Main OpO.

APPENDIX 2, ANNEX F

EXAMPLE OF AN ELECTRONIC WARFARE ANNEX

(Secur cl)

Copy No 1 of 30

Anx E
TO 5 Div OpO 3
Dated 24 Oct 82

EW[1]

Refs: A. M726 GREAT BRITAIN, Sheet 185 (WINCHESTER AND BASINGSTOKE), Edition 2 GSGS, 1:50 000
B. I Corps EW Instr 3 24 Oct 82
C. 5 CDN Mech Div OpO 3 24 Oct 82
D. Int Anx to 5 Div OpO 3 24 Oct 82
E. C-E Anx to 5 Div OpO 3 24 Oct 82

Time Z: ZULU

1. **Situation**

a. **En Forces**

(1) See refs B and C.

(2) En elec ORBAT is not defined. However 5 Div is facing a main atk led by one CAA and sp by another CAA. Strong RECS effort can be expected and tgt on 50% of 5 Div's comd and con resources with pri given to neutralization of bde comd links.

b. **Friendly Forces**

(1) 67 EW Regt and 704 EW Sqn will sp 5 Div EW efforts on req.

(2) Pri of effort to SIGINT until en closer to main def posn. ECM to have pri once en elec ORBAT has been acquired and PIRs have been obtained.

(3) Some EW resources will be deployed fwd of the FEBA.

c. **Atts and Dets**

Under comd forthwith	EW tp 3 Div EW Sqn

2. **Mission**. To provide EW sp to 5 Div's def ops in sec.

3. **Execution**

a. **Gen Outline**

(1) **Concept of Op**. See OpO 3. 5 Div's EW msn implies two tasks: first, to protect our comd and con resources by neutralizing or destroying en RECS and adopting protective emission control measures; second, to atk and neutralize en comd and con resources through appropriate ESM/ECM measures.

(2) **Def EW**

(a) CD Sigs to prep and co-ord div emission control plan.

(b) MIJI reports to be fwd to div EWCC by fastest means to ensure appr and timely DF/CB fire action against en ECM.

(c) Freq to be alloc by pri to surv, fire con, comd and log users. Pri to 1 ACBG, then div resources, then 51 CMB and 52 BMC, then 53 CMB then DISGP.

(d) CD Sigs to ensure restricted freq list takes into acct above pri.

(e) ESM and arty resources to be placed at pri call to neutralize en RECS action against own high pri comd and con resources.

(3) **Off EW**

(a) **Phase 1**. Prior to contact, all ESM/ECM resources to conduct SIGINT ops in sp of int collection plan and to obtain en elec ORBAT. After contact ECM resources to be rel from SIGINT tasks and reasg to tasks per para 3.a.(2)(e) above. ESM to cont to recv pri over ECM. Sp to 1 ACBG to be paramount.

(b) **Phases 2 and 3**. Once the en has reached the FEBA, max ESM to cont but ECM to take precedence whenever nec to neutralize atk MRD's fire and comd and con resources. Pri of sp to 51 CMB and 52 BMC in Phase 2 and to 1 ACBG and 53 CMB in Phase 3. Pri of efforts for ECM resources to:

i. sp of def EW against en RECS effort prior to contact;

ii. neutralization of en fire con resources against 51 CMB and 52 CMB;

iii. neutralization of en comd and con resources in first ech;

iv. neutralization of en fire con resources against 1 ACBG/53 CMB.

b. **51 CMB/52 BMC/53 CMB/1 ACBG**

(1) To enforce emission control plan within area of responsibility.

(2) To ensure swiftness of MIJI reporting.

(3) To sp ECM/ESM tasks as ordered by this HO.

c. **5 Div Arty**

(1) To be prep to neutralize en forces under DF or en jammers.

(2) To coord efforts of loc resources with Div EW Offr.

d. **5 Div EW Sqn**

(1) **Gp**

Under comd forthwith	EW tp 3 Div EW Sqn

(2) **Tasks**

(a) To provide ESM/ECM sp to CD Sigs for div def EW tasks.

(b) To deploy elms fwd of FEBA as nec to conduct EW ops in sp of div covering forces.

(c) To conduct SIGINT tasks in sp of div int collection plan.

(d) To conduct ESM/ECM tasks during Phases 2 and 3 IAW asg pris.

e. **5 Div HQ and Sig Regt**

(1) To execute emission control plan issued by this HQ.

(2) To ensure MIJI reports are transmitted as rapidly as possible.

(3) To provide elec sp to EW Sqn.

f. **67 EW Regt**

(1) Requested to exchange elec ORBAT info through EW channels on first ech CAA.

(2) Requested to exchange info on sec ech CAA activities from Phase 2.

g. **1 Div EW Sqn**. Requested to exchange LOs and elec ORBAT info through EW channels.

h. **2 (US) Corps**. Requested to exchange LOs and elec ORBAT info through TOC/TCAE channels.

j. **Co-ord Instrs**

(1) CD Sigs to coord div def EW tasks with div ops and EW staffs.

(2) Div EWCC to coord off EW tasks with div int, ops and arty cells.

(3) Subordinate fmn sig offrs and sp arms comds to fwd restricted freq proposals by 242000 hrs Oct to CD Sigs who will issue consolidated list by 242200 hrs Oct. Appx 2.

(4) Div EWCC auth direct In with adjacent and higher EW HQ.

(5) No ECM will be conducted during Phase 1, except to counter en RECS efforts.

(6) Delegation of ECM auth to be in effect from Phase 2. ECM con measures to be as per div sops.

4. **Service Support**

a. EW resources status report to be provided to div HQ at 1800 hrs daily.

b. 5 Div HQ and Sig Regt to be responsible for maint of 3 Div EW Sqn asg to div.

5. **Command and Signal**

a. **Loc**

(1) Div EWCC collocated with 5 Div HQ throughout.

(2) Div EWOC located at SWARRATON 5737 for Phase 1.

b. **Sig**. Ref E.

APPXS: 1 - En Elec ORBAT Overlay (not att)

2 - Restricted freq list (not att)

1 When EW does not warrant an annex, EW instrs are included in the main body of the OpO and appear after the engineer sub-para.

APPENDIX 3, ANNEX F

EXAMPLE OF A COMMAND AND SIGNAL PARA TO AN OPO

(Secur cl)

5. **Command and Signal**

a. **Loc**. HQ 1 Div closes present loc and opens at NORTH SHELDON 7831 at 03800 hrs.

b. **Sig**. Anx H.

c. **Elec Silence**. Imposed on all elec eqpt except EW comd links and AD radars at 030900 hrs.

(1) Silence may be broken by the covering force on first contact by codeword HAMMER.

(2) Silence will be lifted by this HQ using codeword TRIPPER.

d. **Codewords**

Serial	Codeword	Meaning	Issued by
(a)	(b)	(c)	(d)
1	HAMMER	Break elec silence	Covering force on first contact
2	TRIPPER	Lift elec silence	HQ 1 Cdn Div
3	SPARROW	Covering force back of the FEBA	Covering force

ANNEX G

FORMAT - COMMUNICATIONS - ELECTRONICS OPERATING INSTRUCTIONS (CEOI)

(Secur cl)

Copy No_____of_____(copies)

Unit
(place of issue)
Date

CEOI No x/xx

Refs: (maps and relevant documents)

Time Z: ZULU

1. **Situation**

(General statement taken from OpO).

2. **Mission**

(To provide C-E instructions for Operation QUICK DIAL).

3. **Execution**

a. **Gen**. (May be necessary to give a general outline of comms requirements in broad terms).

b. **Existing Facilities**. (To include mil, civ or diplomatic facilities and how to use them).

c. **Rad**

(1) **Tac Voice Nets**.

(2) **RTT Nets**.

(3) **Rear Links**.

(4) **Air-Ground-Air**.

(List nets to be exploited; each net is discussed separately as required by changes. Only changes from previous instructions are included. Diagrams may be attached as Annexes to the CEOI.)

(5) **Call Signs**. (If not included in RNIIS package).

(6) **Freqs**. (if not dealt with as a whole in para 3j).

d. **Trunk System**

(1) **RR**

(a) Trunk node deployment,

(b) Routing,

(c) Units to be serviced,

(d) Data,

(e) Directory,

(f) Freqs (if not dealt with as a whole in para 3j).

(2) **Trunk Lines**

(3) **SCRA** (single channel radio access)

(a) RAP (radio access point allocation),

(b) Subscribers,

(c) Freqs (if not dealt with as a whole in para 3j).

(4) **Swbd**

(a) tele directory (changes to existing directory or SOPs),

(b) swbd designators (if not included in RNIIS package),

(c) dedicated ccts/lines,

(d) CNRI (details of CNR interface).

(5) **Satellites**

(a) loc of satellite,

(b) loc of grd stas/terminals,

(c) routing,

(d) channelling,

(e) freqs (if not dealt with as a whole in para 3j).

(6) **Tropospheric Scatter**

(a) route,

(b) channelling,

(c) freqs (if not dealt with as a whole in para 3j).

e. **Line**

(1) pri for laying and rec (changes from SOPs),

(2) locals (changes from SOPs),

(3) trunks,

(4) routes.

f. **Msgcens**

(1) locs/deployment,

(2) ccts (changes from SOPs),

(3) staff/pony ccts,

(4) msg distr,

(5) routing indicators (if not dealt with in para 3h).

g. **Despatch Svc**

(1) SDS, (Schedules and routes - Anx to the CEOI or issued separately),

(2) ADS,

(3) SDR (who may authorize - changes from SOPs).

h. **Sigsec**

(1) DA instrs (changes from SOPs),

(2) Crypto

(a) low level codes (changes from normal),

(b) on line (keylists - any change from normal),

(c) off-line (method, keylists - any changes from normal),

(d) changeover times (changes from SOPs),

(3) RNIIS (method of issue, if changed from SOP - Anx/separate),

(4) routing indicators (changes from SOPs - Anx to the CEOI),

(5) AIGs,

(6) procedures (changes from SOPs),

(7) destruction instrs (changes from SOPs).

j. **Freqs**

(1) asg (normal listed in toto as Anx to the CEOI),

(2) special instrs.

k. **Codewords and Nicknames**. (Pertaining to communications instructions - normally an Anx to the CEOI).

m. **Elec and Rad Silence**

n. **EW** (may include information extracted from EW Anx to OpO).

(1) ECM/ECCM (changes from SON,

(2) Emission policy.

p. **Timings**

q. **Time Standard**

r. **Reserves**

4. **Service Support** (In most cases, only pertinent extracts from the AdmO required).

a. **Gen Outline**. (General statement from AdmO, locs).

b. **Mat and Svcs**

(1) Ammo,

(2) POL,

(3) rats,

(4) water,

(5) tpt,

(6) eqpt replacement,

(7) Engr sp,

(8) sup,

(9) sal,

(10) repair,

(11) rec,

(12) backloading,

(13) misc (local purchase, post, CANEX, etc).

c. **Mod/Evac and Hospitalization**

(1) locs,

(2) evac.

d. **Pers**

(1) MP,

(2) PW,

(3) rfts,

(4) Chaps,

(5) fin,

(6) morale, welfare, pers svcs,

(7) reports/returns,

(8) discipline.

e. **Misc**

(1) RAS (Defence and protection),

(2) CIMIC.

5. **Command and Signal**

a. **Loc**. (of HQ - Main, rear, altn)

b. **Codewords**. (Pertaining to command functions)

ACK Instrs:

Signature of Commander

Authentication:

Annexes: A Comd Net Rad Diagram
B Adm Net Rad Diagram
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DISTRIBUTION:

NOTES ON THE PREPARATION OF CEOIs

1.

a. The headings SITUATION, MISSION, EXECUTION are mandatory. The SERVICE SUPPORT and COMMAND AND SIGNAL paragraphs are optional.

b. Sub-paragraphs are included only as necessary. The headings shown in the preceding outline are given as examples.

2. The contents of a CEOI will depend on how much detail is included in Standing Operating Procedures (SOPs). Together, SOPs and CEOI should include sufficient detail for the efficient execution of the signal plan. It is not possible to lay down what should appear in every CEOI.

3. The list of annexes shown on page 5 is only a guide. An annex is to be used when considerable detail is needed on a particular aspect of the signal plan where the placing of such detail in the main document would make it unwieldy. The annex should be referred to in the relevant section of the main document.

4. Only authorized symbols and abbreviations should be used on diagrams. If it is necessary to use other symbols or abbreviations, they should be explained in a "legend".

5. Distribution lists should show the distribution of the main document and annexes, together with copy numbers.

(Secur cl)

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PHYSICAL COMMUNICATIONS
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POLICY
POWER CONVERTERS/CONDITIONERS
POWER DISTRIBUTION
PRIMARY BATTERIES
PRINCIPLES
PRINCIPLES AND PRIORITIES
PROTECTIVE MEASURES AGAINST RECS
PUBLIC UTILITY SYSTEM
PURPOSE

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RADIO COMMUNICATION BY FORWARD SCATTER
RADIO COMMUNICATION BY RADIO RELAY
RADIO COMMUNICATION BY SATELLITE
RADIO COMMUNICATION BY SKYWAVE
RADIO CONTROL
RADIO PROPAGATION
RADIO RELAY ASSIGNMENTS
RECONNAISSANCE OF SITES

RECORD OF CHANGES
REGIONAL SYSTEM
RELIABILITY
RESPONSIBILITIES
RESPONSIBILITY OF SIGNALS

S

SCOPE
SECONDARY BATTERIES
SECURITY
SIGNAL ESTIMATE
SIMPLICITY
SITING OF HEADQUARTERS
STANDING OPERATING PROCEDURES (SOP)
STRUCTURE
SURVIVABILITY
SYSTEM CONTROL
SYSTEM DEVELOPMENT

T

TELECOMMUNICATIONS
TERMINOLOGY
THE BATTLEFIELD COMMAND AND CONTROL PROCESS
THE ENVIRONMENT
THE FREQUENCY PROBLEM
THE MISSION
THE NBC ENVIRONMENT
TIME AND SPACE
TIMELINESS
TO BE ISSUED
TRANSMISSION CAPACITY

U

UK
USA. SIGMA (To be issued)